VRExplorer: A Model-based Approach for Semi-Automated Testing of Virtual Reality Scenes

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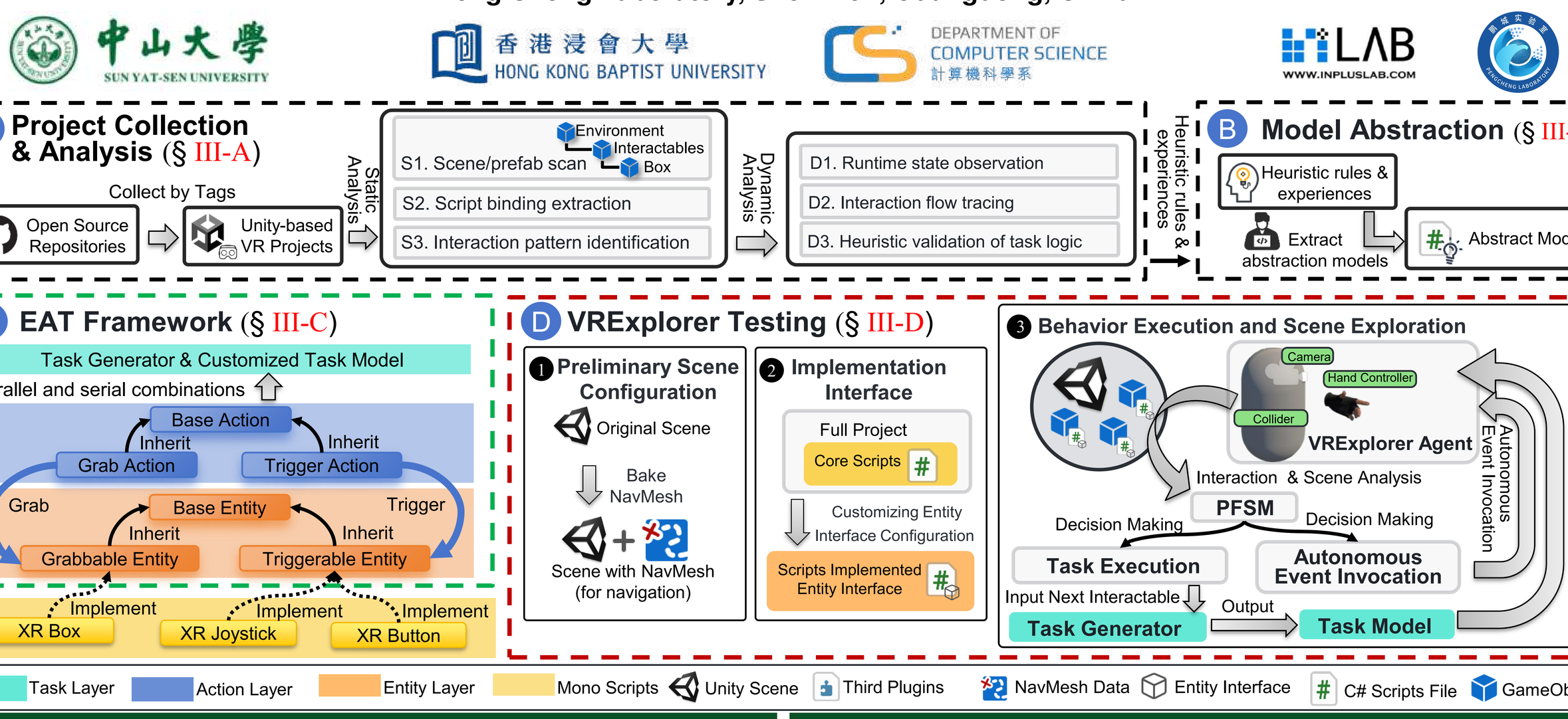

Challenges in VR Testing

- SOTA tools (VRTest[1], VRGuide[2]) fail to fully support diverse VR interactions (e.g., grab, press, shoot).
- Vast exploration space due to complex 3D environments and object interactions.
- Task sequences with interdependent actions (e.g., find key → unlock door → turn handle → press button).

Approach

- **Project Collection & Static/Dynamic Analysis**
- **Model Abstraction:** Generalizes objects and actions into abstract models.
- **EAT Framework:** Three-layer design—Entity, Action, and Task (sequential/parallel composition).
- **Testing Process:** Performing task-based interaction testing via NavMesh navigation & PFSM.

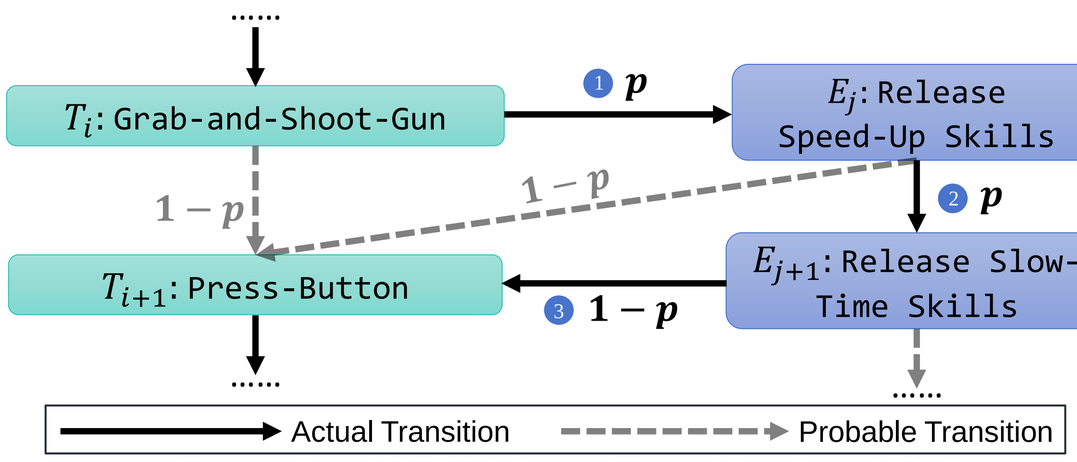

Figure: Example of PFSM State Transition in a VR Scene.

Experiment Results

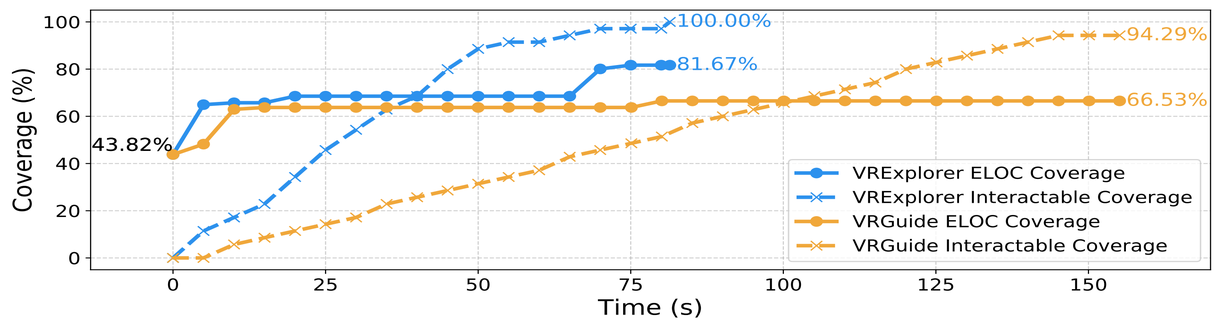

Figure: Coverage versus Time in A Project

- **Performance:** Average gains of +122.8% EC and +52.8% MC vs SOTA on 11 Projects
- **Real Bug Detection:** Found 3 real-world bugs (2 functional, 1 non-functional)
- **Faster Convergence:** Achieves higher coverage with reduced time cost

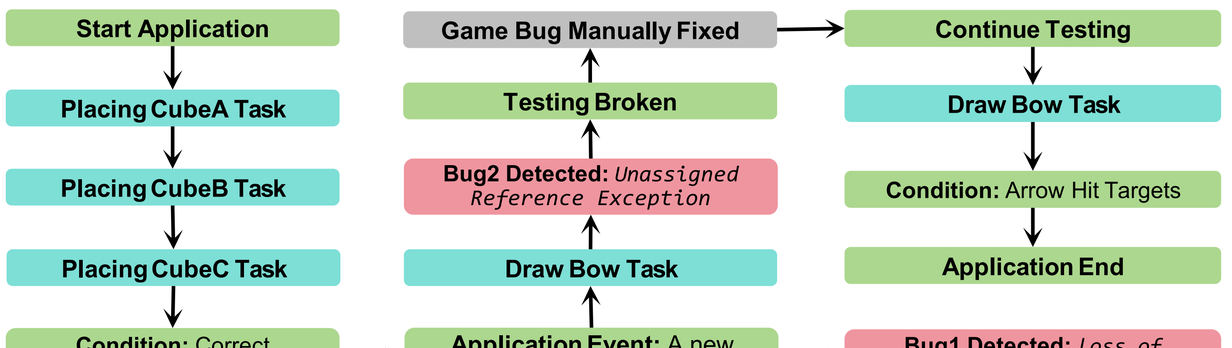

Figure: Example of how VRExplorer explores scenes and detects bugs

References

[1] Xiaoyin Wang. "VRTest: An Extensible Framework for Automatic Testing of Virtual Reality Scenes". In: *2022 IEEE/ACM 44th International Conference on Software Engineering: Companion Proceedings (ICSE-Companion)*. 2022, pp. 232–236.

[2] Xiaoyin Wang, Tahmid Rafi, and Na Meng. "VRGuide: Efficient Testing of Virtual Reality Scenes via Dynamic Cut Coverage". In: *Proceedings of the 38th IEEE/ACM International Conference on Automated Software Engineering*. IEEE Press, 2024, pp. 951–962. ISBN: 9798350329964. DOI: 10.1109/ASE56229.2023.00197.

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