

Compositional Controller Synthesis

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Context

- MOCA (Modeling Control Aspects of Embedded Systems)

Research Goal

- An efficient procedure for synthesizing reactive controllers [1]:

Given a plant P and a property ϕ derive a controller C such that:

$$P \parallel C \models \phi$$

Main Problem

- Scalability, even with state-of-the-art algorithms [4, 5].

Solution Approach

- Modularization [3]: decompose P and C into a control hierarchy and treat the system *compositionally* [2]:

Given two open systems $M_1 = (P_1, C_1)$ and $M_2 = (P_2, C_2)$ and a required guarantee ϕ derive an additional controller C and the weakest context assumptions ψ such that:

$$M_1 \parallel M_2 \parallel C \models \psi \rightarrow \phi$$

An Example: Lego Sorter

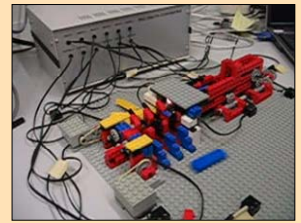


Fig.1 Lego Sorter (toy) example.

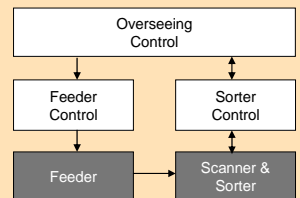


Fig.2 A hierarchical model of the Lego Sorter.

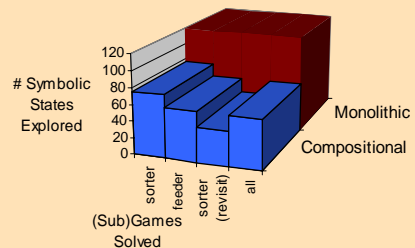


Fig.3 Synthesis Results for Lego Sorter.

References

- [1] Peter J.G. Ramadge and W. Murray Wonham, "The control of discrete event systems," *Proceedings of the IEEE* 77, no. 1 (1989): 81-98.
- [2] Krishnendu Chatterjee and Thomas A. Henzinger, "Assume-Guarantee Synthesis," in *Tools and Algorithms for the Construction and Analysis of Systems*, vol. 4424, LNCS (TACAS 2007, Springer, 2007), 261-275.
- [3] Arindam Chakrabarti e.a., "Synchronous and Bidirectional Component Interfaces," in *Computer Aided Verification, 14th International Conference, CAV 2002 Copenhagen, Denmark, July 27-31, 2002 Proceedings*, vol. 2404, LNCS (CAV 2002, Springer, 2002), 711-745.
- [4] Krishnendu Chatterjee e.a., "Algorithms for Omega-Regular Games with Imperfect Information," in *Computer Science Logic, 20th International Workshop, CSL 2006, 15th Annual Conference of the EACSL, Szeged, Hungary, September 25-29, 2006. Proceedings*, vol. 4207, LNCS (CSL 2006, Springer-Verlag, 2006), 287-302.
- [5] Franck Cassez, "Efficient On-the-Fly Algorithms for Partially Observable Timed Games," in *Formal Modeling and Analysis of Timed Systems, 5th International Conference, FORMATS 2007, Salzburg, Austria, October 3-5, 2007. Proceedings*, vol. 4763, LNCS (FORMATS 2007, Springer, 2007), 5-24.