Programming Robotic Devices with a Timed Concurrent Constraint Language

María del Pilar Muñoz and Andrés René Hurtado

Universidad Javeriana, Colombia
mpmunoz@puj.edu.co and arhurtado@puj.edu.co

This work shows the implementation of *ntcc-lman* [1], a framework for `ntcc` [2], a non deterministic timed concurrent constraint process calculus. This calculus provides a formal model in which concepts proper to robotic control can be conveniently represented. The *ntcc-lman* framework includes a `ntcc` based kernel language, a compiler, a constraint system, a formal abstract machine based on `ntcc` reduction rules and a virtual machine. We show how the framework can be used to program typical robotic tasks to control *LEGO* robots in real time using *timed ccp* technology. To our knowledge, this is the first *timed ccp* framework for programming robotic devices.

The *ntcc-lman* framework was motivated by the increasing interest and the theoretical work in process-calculi as a formal framework for concurrent constraint languages. The goal of our project was to develop a formal framework for `ntcc` and to analyze its expressiveness in programming robotic devices. In efficiency, the work presented is quite competitive with other programming languages for *LEGO* robots, such as LUSTRE and ESTEREL, both synchronous languages for *LEGO* robots and *jcc*, of relevance to our work as an implementation of **tcc** that compiles **tcc** into Java. The novelty of the *ntcc-lman* approach is to offer a very robust framework combining the benefits of a formal foundation in process-calculi with a real-world application in which it is possible to program robotic tasks and prove their temporal properties.

We believe the *ntcc-lman* framework is also suitable for other type of applications. We are currently including a *midi* interface in order to test some non-trivial music improvisation processes that have already been successfully modeled in `ntcc` . These kind of applications are interesting for our framework because they are inherently non deterministic and temporal. Finally we are exploring the use of the framework as a tool to introduce constraints and concurrency in computer science undergraduate courses.

References

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