Synchronous Programming
for Realtime Performance

Supervisors: Marc Pouzet (LIENS) and Florent Jacquemard (IRCAM).
Contact : `florent.jacquemard@inria.fr`

Context : The context of this internship is mixed instrumental/electronic music performance, where a computer has to play an electronic music score in realtime synchronization with a live musician. The Antescofo [1] system, developed at IRCAM, is regularly used for this purpose in concerts worldwide, with two main components consisting of a machine listening system coupled to a synchronous programming interface.

The first component analyses the audio stream of the musician and decodes in realtime the position within its score and the current tempo (pace) [2].

The second component acts as a sequencer : it receives the decoded information and, in response, sends messages after some specified delays to an external component in charge of playing some computer realized elements. This last functionality can be compared to the synchronous programming paradigm, where a program waits for input events and emits output actions in the same logical time as the reception of events.

The music scores currently used in Antescofo, consist essentially in the specification of sequences of the musical events decoded (from the performer audio stream in input) and of electronic actions to be output by the computer in response. Various strategies are also proposed for specifying synchronization between events and actions and for error handling [3].

Objectives : The goal of this internship is twofolds. The first is to design a procedure translating an Antescofo score into a synchronous program realizing the sequencing module. Two approaches will be explored : one based on the declarative specification of streams as developed in languages like Lustre or Lucid synchrone, the other based on a more imperative flavor using construct available in ReactiveML or Esterel. The second objective is to investigate the relevance of the static analysis tools that have been developed in the synchronous languages community to the analysis of Antescofo partition.

The objectives are to study :
– semantics for Antescofo based on the synchronous programming paradigm
– a proof of concept for the use of synchronous programming languages in the context of music performance, and identifying which synchronous language is better suited for this purpose
– using the synchronous implementation of the sequencing module as a black box for test procedures, e.g. for testing the robustness of the error handling strategies
– using of causality analysis and timing analysis techniques and tools developed for synchronous languages

The internship will be between the Parkas team at ENS and the Repmus team at IRCAM and the student is expected to spent time in the two locations.

Références

[1] http://repmus.ircam.fr/antescofo, May 2011.

[2] A. Cont. A coupled duration-focused architecture for realtime music to score alignment. *IEEE Transaction on Pattern Analysis and Machine Intelligence*, 32(6) :974–987, 2010.

[3] J. Echeveste, A. Cont, J.-L. Giavitto, and F. Jacquemard. Formalisation des relations temporelles entre une partition et une performance musicale dans un contexte d'accompagnement automatique. In (MSR'11), volume 45 of *Journal Européen des Systèmes Automatisés*, pages 109–124, Hermès, 2011.