Hybrid systems and control
Christophe Prieur and Andrew Teel
EECI Graduate Course 2008

Instructors: Christophe Prieur and Andrew Teel

Organization and contact:

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Course Home Page:
http://www.laas.fr/~cprieur/Courses/eecl08.html
It contains some useful informations, the content of the course, the schedule and some references.
The references of the instructors may be downloaded (please ask for a password).

Course description:
Hybrid systems are systems modeled by discrete dynamics (e.g. a resetting subordinated to logic-even) combined with continuous dynamics (e.g. a physical parameter). Also, although many control systems are usually described by either a continuous-time model or a discrete-time model, when designing a stabilizing feedback, it may be necessary (or more efficient) to consider a hybrid feedback law (e.g. with some flows and some jumps). In this context, the system in closed loop becomes hybrid.

In the first part of this course, we recall some notions and some tools for the stabilization of control systems by means of (dis)continuous state-feedbacks. In the second part, we introduce a class of hybrid systems and define a notion of solution for such systems. This leads to several engineering applications with the hybrid systems framework. We study the stability theories by focusing on the KLL stability, robust KLL stability, and necessary and sufficient conditions for stability of hybrid systems.
systems. Several examples illustrate this part. In the third part of this course, we consider the
design problem of hybrid feedbacks for nonlinear control systems. Some theoretic applications of
these technics are given, including robust stabilization problems or optimal control theory. Also
some applications are considered in robotics or in embedded systems. In the last part of this course,
the problem of the output regulation by means of hybrid controllers is studied.

The course is suitable for engineering and mathematics students who are familiar with basic linear
control system theory.

Program:

• Notions of stability of nonlinear control systems;
• Definition of hybrid systems, notion of solutions, stability with respect to perturbations;
• Design of hybrid feedbacks for nonlinear control systems. Theories and examples;
• Applications;
• Hybrid output feedback laws.

Outline of the course:

First part Classical system theory [CP - three sessions]
Second part Hybrid systems theory [AT - four sessions]
Third part Hybrid stabilizers [CP - three sessions]
Fourth part Further control applications [CP -one session and AT - three sessions]

Timetable:

The duration of the course is 21 hours. It is splitted into 14 sessions with a duration of 1.5 hours
each. In the following table, “AT” (resp. “CP”) means that the instructor is Andrew Teel (resp.
Christophe Prieur).

<table>
<thead>
<tr>
<th>Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
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<tbody>
<tr>
<td>9:00am - 10:30am</td>
<td>Slot 3: CP</td>
<td>Slot 7: AT</td>
<td>Slot 9: CP</td>
<td>Slot 13: AT</td>
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<td>11:00am - 12:30pm</td>
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<td>Slot 8: CP</td>
<td>Slot 10: CP</td>
<td>Slot 14: AT</td>
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<td>Slot 5: AT</td>
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<td>Slot 11: CP</td>
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<td>Slot 6: AT</td>
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<td>Slot 12: AT</td>
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References


