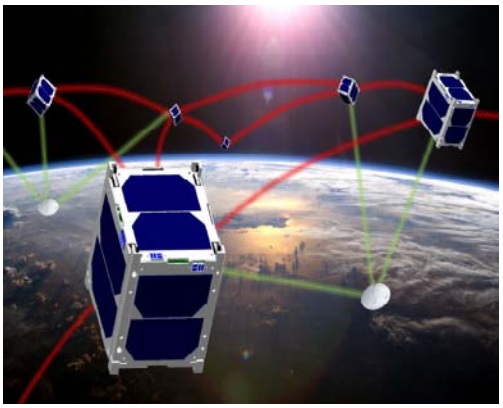
Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Institut für Informatik
Lehrstuhl VII
Robotik und Telematik
Prof. Dr. Klaus Schilling

FORMATIONS OF AUTONOMOUS GROUND AND AIR VEHICLES



Intensive course
by
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Course Details:

Vorlesungszeitraum: Blockvorlesung, 2 SWS anrechenbarer Vorlesungsumfang
Startveranstaltung: 29.04.2010 um 10 Uhr in Raum B202.
Kontakt: Prof. Dr. Klaus Schilling (schi@informatik.uni-wuerzburg.de)

Course Contents:

REVIEW: MODELING AND CONTROL OF MOBILE ROBOTS (2 hrs)

- Direct kinematic and dynamic models, model inversion and control of mobile robots with front wheel driving & steering and driving with differential rear wheels subject to velocity constraints
- Kinematic and dynamic models, control of uninhabited air vehicles (UAV)
- Output feedback linearization and state feedback control of motion with non-holonomic constraints.

FORMATIONS MOTION MODELING AND INDIVIDUAL ROBOTS CONTROLLERS DESIGN (4 hrs)

- Dynamic model based on relative distance: inter-robots and to the formation center
- Desired formation representation: straight front line, platoon, V-shape, arc of circle, ellipse, curved, etc.
- Formation motion coordination using virtual leaders, master-slave and distributed authority controllers
- Individual robot controller design using formation model inversion, output linearization, predictive controllers and fuzzy logic
- Collision avoidance and formation holding constraints verification

SIMULATION USING ENCAPSULATED SUBSYSTEMS (6 hrs)

- Encapsulated Matlab/Simulink models for:
  - Front wheel drive and steering robots, real-wheels differential driving robots
  - Fixed wing UAV
  - Dynamic inversion, state feedback linearization, predictive controllers
  - Formations using virtual leaders, master-slave and distributed authority controllers, desired formations geometry

ISSUES REGARDING SELF-ORGANIZING EMERGENT FORMATIONS OF AUTONOMOUS ROBOTS (6 hrs)

- Characteristics of self-organizing emergent systems: natural and engineered systems
- Extended Kalman filter sensor fusion of signals from accelerometers, wheel encoders, digital compasses and range sensors on each robot
- Inter-robot communication and sensor information integration
- Real-time control issues: same for each robot, for different desired geometries of the formations in case of stabilization and tracking missions
- Formation stability subject to various initial conditions, mission complexity and component failures.