A5.2 Mobile Systems – Control

Time: Tuesday, 14.09.2010
Location: Humboldt-Building, Lecture Room 211
Chairman: Th. Rauschenbach (DE-Ilmenau)

1:30 p.m.	O. Sokolov, W. Hussein, O. Sokolov (UA-Kharkov)

Fuzzy control of Autonomous Quad-Rotor
This article is devoted to control of autonomous quadrotor. High maneuverability and controllability of this flying robot especially in enclosed areas allow to generate new tasks for its motion. We propose two-level control system. The first (inner) level is a fuzzy logic rule base that control of stabilization of quadrotor according to its space parameters. The second (outer) level is used for navigation tasks according to external environment. Namely, we propose to use multi agent approach for estimation of situation of robot and making autonomous decision about its navigation to avoid of unexpected obstacles or wind. The decision making is based on fuzzy logic that allow to generate the best decision in the space of parameters. To recognize the environment we propose vision-based navigation system. Video processing allows to calculate the space parameters and Euler angles of the robot. The identification subsystem consists of block of calculation of projective transformation and estimating of coordinates of robot in 3D space. We illustrate the approach of control on the mathematical model of autonomous quadrotor that realized in MatLabSimulink. The next stage of work will involve closing the outer control loop with more intelligent functions.

1:50 p.m.	D. Goldbach, Ch. Ament (DE-Ilmenau)

Stabilized Reversing With Vehicle Trailer Combinations
Reversing with a vehicle trailer combination is difficult for unskilled drivers because the trailer has to be guided through permanent steering commands. The kinematics of such a system forces the steering commands to be in the opposite direction compared to driving forwards. A driver reversing can be assisted by controlling the angle between the longitudinal axle of the towing vehicle and the longitudinal axle of the trailer. The set value for the combination's articulation angle depends on the towing vehicle's steering angle, wheelbase and position of the hitch and the trailer's towing bar length. The trailer is steered by lateral movement of the hitch and therefore the trailer's coupling point. Based on a simple kinematics behaviour model of the combination's articulation angle a simple algorithm to generate the set value is derived. Based on the same model a towing vehicle velocity adaptive controller algorithm is derived using ackermann's formula. The algorithms were successfully tested in a prototype vehicle using rapid control prototyping equipment. As example results of reversing without steering wheel action straight with more than 20 kmh and parts of steady state skidpad testing backwards without corrective actions through the driver are shown.

2:10 p.m.	C. Zschippig, Th. Behrmann (DE-Bremen)

The Intelligent Car Seat – Model Base for Comfort Control of Active Climate Seats

To achieve optimal performance and traffic awareness, a driver has to feel comfortable in the car. One aspect for the comfort in a vehicle is the climate. Today, state-of-the-art cars feature automatically controlled climate in the passenger compartment, with individually set parameters for each car occupant. In addition, thermal comfort can be altered by manually controlled active climate seats. These seats are equipped with seat heating, typically electrical, and seat cooling, implemented using fans. The thermal environment in the car cabin changes dynamically, due to various influences like direct solar irradiation. Since the seat is controlled manually, the seat occupant has to react to the changing climate. Due to the nature of human thermal sensation, the seat occupant will react only after an uncomfortable situation has already arisen. With a comfort control implemented in the seat, uncomfortable situations like sweat accumulation in the cloths could be prevented. While the comfort sensation for static environments can be reasonably well predicted, there is still question as to how individuals percept dynamically changing thermal conditions. Which influence do the thermal control mechanisms of the human body have and how can these subjective comfort sensations be objectively measured? Can these parameters be measured non-invasively, without the car occupant having to place sensors actively onto the body? The main issue of this paper is to analyze the contribution potential of car seat climate control to the provision of a comfortable thermal environment, in the face of dynamically changing boundary conditions. To achieve this, data of sensors embedded in the active climate seat is evaluated. The limitations and necessities for further research are evaluated.

2:30 p.m.	D. Eck, S. Biedermann, K. Schilling (DE-Würzburg)

Adjustment of the Hand Throttle of a Mobility Scooter for Elderly People

Mobility is one of the biggest issues for a self-determined life, in particular for elderly people. Social participation and daily activities like shopping, errands or doctor visits requires mobility. Therefore mobility is a prerequisite to maintain autonomy and self-determination in old age. A part of the Fit4Age project is the development of a mobility scooter to support the mobility of elderly people. The mobility scooter will be equipped with drive assistance function, like obstacle avoidance, to relieve the operator from the challenging control of the vehicle. Furthermore autonomous functions, like human following, and a navigation system, adapted to the requirement of the mobility scooter will be integrated. The objective of this paper is one of the drive assistance functions: the adjustment of the hand throttle configuration. First of all, a velocity controller was integrated on the mobility scooter. Therefore the characteristics of the vehicle and the motor were simulated in Matlab to determine appropriate PI-controller parameters, later evaluated and further adapted to the mobility scooter hardware. Additionally a new regulation of the hand throttle was implemented. Originally the velocity between 0 km/h and 15 km/h ranges proportionally over the complete hand throttle. Different new regulations (e.g. 0 km/h – 3 km/h proportionally in the first 70% and the last 30% evenly between 3 km/h and 15 km/h) were implemented. The velocity controller and the different regulations of the hand throttle were evaluated and tested by several elderly people to find the best configuration. The result enables the operator an easy and safe control of the mobility scooter, especially at narrows and at slow velocities.

2:50 – 3:10 p.m. Coffee break

3:10 p.m.	H. Renkewitz, Th. Pfützenreuter (DE-Ilmenau)

A Generic Guidance System for Underwater Vehicles
Today, it is not exceptional for an institution to own several different autonomous underwater vehicles. Despite the nice effect of having multiple platforms available, this can easily become a challenge for the user and even more for a system designer. Each vehicle is usually equipped with a native control system and hardware specific modules. The Fraunhofer Application Center System Technology in Ilmenau (Germany) currently possesses three underwater vehicles (both AUVs and remotely operated vehicle's, ROVs); another novel vessel is being developed. All vehicles are equipped with individual guidance systems. Thus, modifying and creating new software, planning missions and evaluating them has to be done in very different ways. This fact shows the necessity to develop a new software framework for underwater vehicles. It is called ConSys (short for Control System) and offers the following features: • Vehicle independent guidance system: development of a - as far as possible - vehicle independent control system for AUVs and ROVs, including autonomous and teleoperated manipulation capabilities, • Graphical user interface: easy to use, extensible, task-oriented application for mission planning and evaluation, • Abstraction layer: complete platform-independent abstraction layer for all necessary interfaces for the running operating system, sensor and actor buses, • Software structure and communication: support of modular control systems with simple and powerful inter-process communication mechanisms. All of these features will be fully described in the paper.

3:30 p.m.	M. Jacobi, S. Matz, F. Schrödel (DE-Ilmenau)

A Practical Workflow for AUV Control System Design
Recently, autonomous underwater vehicles (AUVs) have gained more and more importance in performing tasks such as inspection, exploration and deep water. Many AUV missions can be only done once or without repetition. Therefore, task specific algorithms cannot be improved with experiences gained during missions; test missions and test scenarios have to be used instead. The task specific algorithms (e.g. for control and parameterization) need validation and evaluation to be function in a safe manner. We developed an environment and tools for testing and evaluating these algorithms. The development process of these specific algorithms consists of: • Vehicle development o geometric boundaries specification • Mathematical modeling o motion equation for vehicle movements o hydrodynamics • Controlling o analysis of dynamic equations for stability etc. o controller design • Virtual Reality o sensor definition o 3d vehicle models • Test basin o integration test: hardware and software All these steps are connected and influence each other. In this paper we will present an exemplary method for the controller and algorithm design using methods provided by the testing environment developed at the Fraunhofer Application Center System Technology.

End of lecture session