A4.1 Model-Based Process Optimisation and Control

Time: Monday, 13.09.2010
Location: Humboldt-Building, Lecture Room 013
Chairman: Prof. P. Li (DE-Ilmenau)

1:30 p.m.	H. Große-Löscher (DE-Ilmenau)

Particle Swarm Intelligence: A Particle Swarm Optimizer with Enhanced Global Search Qualities and Guaranteed Convergence

A new particle swarm optimizer is presented. The paradigm of particle swarm optimization - PSO - was published in 1995 by Russell Eberhart, an electrical engineer and James Kennedy, a social psychologist. This relatively young algorithm is related to swarm intelligence and evolutionary computation. Originally intended as a graphical simulation for the choreography and the social milieu of a bird flock, the originators realized the potential of this method to optimize continuous nonlinear functions. Particle swarm optimization is a metaheuristic that proved to be very simple, robust and efficient. Particles are potential solutions of the function to be optimized. Cognitive and social components are attracting the particles while moving through the search space with a direction-dependent velocity. The algorithm is not limited regarding dimensionality or complexity of the optimization task. In addition to a basic introduction to particle swarm optimization, the performance of the algorithm in a static and three different dynamic environments is graphically demonstrated by a synthetically generated 2D test case illustrated by picture sequences and animations. The implementation of a refined constriction coefficient strategy influencing the particles' velocities led to a significant improvement in global search ability and a feasibility to guarantee final convergence, softening the original swarm characteristics. A comparison to the canonical PSO and a later introduced improved version is conducted. Furthermore, drawbacks of the conception for static operation applied to dynamic tasks, such as a phenomenon called 'linear collapse' are highlighted. Finally, the application of PSO to a static engineering problem with 361 parameters is described.

1:50 p.m.	M. Ritzmann, M. Bischoff, M. Golz, R. Böse (DE-Schmalkalden)

A new Methodology for Optimization of the Geometric Highway Design Process

This paper concerns the interactive 3D alignment and visualization of roadways as part of a new methodology for the highway geometric design process. A basic concept of the step of pre-planning is presented based on an alternative but simple interpolation model to circumvent the disadvantages of conventional 2D pre-planning. It is shown that quality management of the geometric design process is supported with regard to several criteria of safety, economy and aesthetics. Optimization in terms of safety takes into consideration that there are complex relations between the road, the vehicle and also the driver. Several aspects of these relations are tested and validated during driving simulation which is supported optimally by 3D design proposed. A new work-place is proposed in order to integrate driving simulation into the design process without requiring much effort from engineers. Finally, the new methodology is compared to the conventional one. For this commercial tools as well as subjective ratings of long-standing experts in road design are considered.

2:10 p.m.	M. Schulz (DE-Ilmenau)

Optimized Maintenance and Logistic Process
Model-based design using executable models has the potential to increase system design efficiency and accuracy significantly. In our department we work on an industrial application which covers system design issues in the area of avionics and airline operation, especially taking into account maintenance and logistics operations and their impact on fleet availability. In this paper is present an optimized maintenance and logistic process. Such a complex process needs to be modeled on a very abstract level of detail in the early phases of design, and undergoes a stepwise refinement throughout the further development. Executability of a model ensures that the model is a behavioral specification, and allows simulation runs for a performance evaluation of process alternatives. Decisions can thus be made with more confidence. We use the software tool MLDesigner in the paper, which is capable of modeling an evaluating hierarchical multi-domain models of complex processes. Different models of computation for submodels can be mixed, and an extensive library of predefined modules is available. Here is present parts of an abstract maintenance and logistic process model from an ongoing project, which is used to evaluate, among others, resource availabilities.

2:30 p.m.	K. Treichel (DE-Ilmenau), J. Jouffroy (DK-Sønderborg)

Real-time sail and heading optimization for a surface sailing vessel by extremum seeking control
Autonomous sailing vehicles like sailboat- or the so-called landyacht-robots are relatively new amongst other fully automated vehicles such as autonomous aerial, marine, submarine or road vehicles. However, in comparison sailing vehicles have a great potential due to their clean, nonpolluting means of propulsion – the wind, also representing a challenge in automation and control. A concern of most sailors is to optimize the longitudinal velocity or surge along a specific heading by trimming the sail in the best possible way, as well as maximizing the so-called velocity made good (VMG). For that purpose we develop a simplified mathematical model representing the main elements of the behavior of sailing vessels as a basis for simulation and controller design. For adaptive real-time optimization of the sail and heading angle we then apply Extremum Seeking Control (which is a gradient based control law that drives the output of a linear or nonlinear system to its extremum) as an approach to maximize the longitudinal velocity and the VMG respectively. The basic idea behind extremum seeking and "how it works" is presented, as well as a simulation study on noise, convergence and stability issues.

2:50 – 3:10 p.m. Coffee break

3:10 p.m.	A. Bulgakov, A. Pruglov (RU-Nowotscherkassk)

Mobile Flexible Automatized Producing Line for Manufacturing of Elements of Prefabricated Wooden Houses
Mobile Systems Principles of organization, optimization and automatization of construction processes are analyzed in the article. The functional scheme of mobile flexible automatized

producing line for manufacturing of elements of prefabricated wooden houses is proposed. Analysis of economic effectiveness and competitiveness of the line is realized. Design and development of automated manufacturing and of the flexible automatized line for manufacturing of elements of prefabricated wooden houses in particular is a complex problem. Having been studied peculiarities of the construction of panel houses it is proposed to divide the technological process of manufacturing of sheet walls and other prefabricated elements into six technological sections. One should mention that the sections are located specifically: the outgoing production of one section is the incoming production of the nest one. The technological process must be organized in such a way that at the point of entry logs are loaded and the finished construction elements and panels come off the last section. As a result of the realized analysis such factors as a positive economic effect of the introduction of the line into the sphere of construction activities (reduction of the cost per 1 m^2 of the floor) and improvement of the quality of prefabricated wooden houses due to the complete robotization of technological processes were revealed.

3:30 p.m.	T. Stolze, K.-D. Kramer (DE-Wernigerode), W. Fengler (DE-Ilmenau)

Tool-assisted Hardware Selection with "UBCS"
A correct decision for selecting a certain system, based on well-founded information, is essential for the development of a new product and its success on the market. Especially small and mid-size companies only have no or very limited human and technical resources. In most cases, there is no chance to run complex and time-demanding tests with potential systems to prove the appropriateness for the product. Therefore, a system for this use case, the support of a correct selection of a certain system, is currently developed at Harz University. This so-called "Universal Benchmark and Compare System", abbreviated "UBCS", supports developers when choosing suitable hardware. It contains various benchmark results of different target systems such as Microprocessors, Microcontrollers and Digital Signal Processors. Moreover, it also provides relevant information like technical specifications that are important for product development. "UBCS" is intended to suggest ideal hardware for a certain set of requirements. That is why developers are supported optimally during the mentioned phase and are able to select hardware in a future-proof and strategic planning way, while other information like future costs and availability are provided simultaneously. The paper focuses on "UBCS" from a point of view concentrating on the technical implementation, presents advantages resulting from using "UBCS" and provides a general view to present the project's development.

End of Lecture Session