

## A6 Control of Mechatronic Systems

Time: Monday, 13.09.2010

Location: Humboldt-Building, Lecture Room 204

Chairman: S. Lambeck (DE-Ilmenau)

1:30 p.m.	O. Tolstykh, A. Balkovoy, V. Cacengin, G. Slivinskaya (RU-Moskau)
<p><b>Control of Direct System</b></p> <p>In many applications, independently of the motion type (linear or rotating) the direct drive systems have essential advantages in compare with the other motion systems like the motor-driven ballscrew, the motor-driven worm gear etc. The elimination of the mechanical gear provides extremely dynamic, high smoothness and precision. Moreover, thanks the relatively simple construction and minimal number of moving parts, the direct drives have extended lifetime and require no maintenance. On the other hand, in such a system, since the load is directly coupled with driving motor, any force/torque fluctuations due to non-ideal construction of the driving motor and the disturbances due to the position sensor uncertainties will negative affect on quality of motion and positioning of the load. This problem can be solved by the optimization of the driving motor construction and use the high-precision position sensor like optical encoder. However, this solution increases the cost of the direct drive system. Another way to create the high-precision direct drive system is to use the relatively low cost components and special control concept, which improves the motion performance by taking into account and compensation of force/torque deviations and uses special algorithms for position sensor error correction. This description of the direct drive system with such a control concept and results of its implementation are the main aim of this paper. The direct drive system, described in this paper, consists of the digital amplifier and the rotary table with torque motor and position measuring system based on absolute resolver. The paper contains the direct drive control concept description and several verification tests like the low speed test, the short indexing test, the high dynamic start/stop mode, the accuracy and repeatability verification according to ISO 230-2:2006 (results: accuracy – 30 arcsec, repeatability – 4 arcsec).</p>	

1:50 p.m.	V. Piwek, B. Kuhfuss, P. Wilhelmi (DE-Bremen)
<p><b>Solution for a High Dynamic Drive System</b></p> <p>Presented is a solution for a high dynamic drive system for linear motion in sections to avoid the goal conflict between high movement speed and high drive torque, which is required using conventional linear axis. In this article it is described how it can be succeeded by separating the main function "driving" in to the sub-functions "driving", "accumulate energy" and "enable energy". Within the displayed solution the drive side of the system, consisting of a servodrive and a ball screw, is extended by a mechanical energy storage which allows a significant increase of dynamic on the output side by the application of an additional brake system (fig. 1). Fig 1: Schematic diagram Besides the basic mechanical design of this system particularly the requirements on the control engineering are in focus and the effect is shown by developing a numerical process model (MatLab-Simulink). These interrelationships are illustrated with the help of a functional model (fig. 2) and verified by measuring the position with a laser interferometer. Fig 2: CAD modell of the functional model Concluding applications for the described system are shown and in the field of spooling machines of strip stock one is exemplified. The article closes with an outlook on further steps to adjust this solution for the industrial environment.</p>	
2:10 p.m.	R. Neugebauer, S. Hofmann, A. Hellmich, H. Schlegel (DE-Chemnitz)
<p><b>Time-Based Parameter Identification And Controller Design For Motion Control Systems</b></p> <p>Today, a cascaded system of position loop, velocity loop and current loop is standard in industrial motion controllers. Each controller has to be designed according to its subordinated system behavior. Usually, the controller commissioning is realized in the frequency domain. The resulting open-loop frequency response needs to satisfy the defined requirements (e.g. phase margin). In contrast to that, in controller engineering several tuning rules are applicable, for example the amplitude optimum or the symmetrical optimum. Therefore, an accurate parametric model is required. The paper presents a method for the identification of various plant parameters in the time domain. The approach is based on the auto relay feedback experiment by Åström/ Hägglund and a modified technique of gradual pole compensation. It is exemplified on the open velocity loop. Here, the moment of inertia and the time constant of the closed current loop are the significant parameters. In addition to a theoretical description, the paper presents the implementation as an automatic application in the motion control system SIMOTION. Finally, the velocity controller is adjusted with various tuning rules, based on the identified plant parameters. Furthermore, the identification results as well as the achievable controller performance on a test rig will be presented.</p>	

2:30 p.m.	A. Bulgakov, A. Fedorova (RU-Novotscherkassk)
<p><b>Intelligent Controller for Light Weight Robot</b></p> <p>Power Engineering Modelling and control of flexible multi-robot has recently received a wide attention from specialists in structural dynamics, mechanical engineering, and automatic control. If the various links of a manipulator are to be considered rigid, they must be structurally stiff, and this leads to bulky and massive designs. A simple adaptive scheme control structure is used to dampen the end-point vibration. It is consisted from PID controller to stabilize the system and the neural network with feedback error on-line learning scheme to control the elastic deflection by computing the joint torque that position the end effector of flexible robot along prescribed trajectory. The error in tip total displacement is used in calculating and forming the PID controller. Simulated case-studies for flexible arm had shown the effectiveness of the suggested control design scheme. Using the tip total displacement, and the feedback error on-line learning scheme of the neural network resulted in a significant reduction in the end-point vibration of the flexible link robot manipulator. Combining the PID controller with the neural network was found to improve the trajectory tracking and controlling the end-point vibration of the flexible manipulator during the tracking process and after reaching the desired position.</p>	
<p><b>2:50 – 3:10 p.m. Coffee break</b></p>	
3:10 p.m.	A. Winkler, L. Böhme, J. Suchý (DE-Chemnitz)
<p><b>Collaboration of Robots under Force/Torque Control</b></p> <p>Force/ torque control of robot manipulators has been quite intensively investigated during the last decades and it becomes more and more important concerning manufacturing tasks. However, in the case of cooperation between industrial robots, they are predominantly position controlled. This article deals with force/ torque control based robot-robot collaboration. For demonstration a challenging task will be selected - the assembly of a screw fitting by two force/ torque controlled robot arms. This experiment will be performed using hybrid position/ force control. For the implementation two industrials robots with its original controllers have been used. This fact reduces the possibilities of force/ torque control with respect to controller structures and parameters.</p>	
<p><b>End of Lecture Session</b></p>	