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Improving the role of research +development+innovation in the higher education through institutional developments assisting intelligent specialization in Sopron and Szombathely

Innovative processing technologies, applications of energy engineering and implementation of wide range techniques for microstructure investigation

Workshop on Innovative Materials Processing, Applications in Energy Engineering and System Control

Szombathely, 2019

SZÉCHENYI  **2020**



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BEFEKTETÉS A JÖVŐBE



**Workshop on Innovative Materials Processing, Applications in Energy
Engineering and System Control**

Chairpersons: Dr. Jurij SIDOR and Dr. László KOLLÁR

Date: February 22, 2019

**Venue: Eötvös Loránd University, Faculty of Informatics, Savaria Institute
of Technology, Károlyi Gáspár tér 4, 9700 Szombathely, Hungary
Room #: B209**

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the role of research +development+innovation in the higher education
through institutional developments assisting intelligent specialization in
Sopron and Szombathely’**

Program

8.55-9.00 Jurij Sidor: *Introduction*

9.00-9.15 Luis Rubio Rodriguez

Automated Control of Machining Processes

**Eötvös Loránd University, Faculty of Informatics, Savaria Institute of Technology,
Szombathely, Hungary.**

9.15-9.30 Yiqing Meng and László E. Kollár

Active vibration absorber for aeolian vibration control on suspended cables

**Eötvös Loránd University, Faculty of Informatics, Savaria Institute of Technology,
Szombathely, Hungary.**

9.30-9.45 László E. Kollár

Aerodynamic Performance Degradation of Wind Turbine Blades due to Ice Accretion

**Eötvös Loránd University, Faculty of Informatics, Savaria Institute of Technology,
Szombathely, Hungary.**

9.45-10.00 Kristóf Lajber

Development of an intelligent vehicle control system

**Eötvös Loránd University, Faculty of Informatics, Savaria Institute of Technology,
Szombathely, Hungary.**





10.00-10.15 József Szölősi

Designing of beam welding technologies for carbon steel structures

**Eötvös Loránd University, Faculty of Informatics, Savaria Institute of Technology,
Szombathely, Hungary.**

10.15-10.30 Tibor Borbély and Jurij J. Sidor

Rolling mill design challenges

**Eötvös Loránd University, Faculty of Informatics, Savaria Institute of Technology,
Szombathely, Hungary.**

10.30-10.45 Dániel Fenyvesi and Jurij J. Sidor

Finite Element modelling of deformation flow in symmetric and asymmetric rolling processes

**Eötvös Loránd University, Faculty of Informatics, Savaria Institute of Technology,
Szombathely, Hungary.**

10.45-11.00 Gyula Pál and Jurij J. Sidor

Comparison of microstructure evolution after symmetric and asymmetric rolling

**Eötvös Loránd University, Faculty of Informatics, Savaria Institute of Technology,
Szombathely, Hungary.**

11.00-11.15 Jurij J. Sidor

Application of polycrystal models to simulation of texture evolution in thermo-mechanical processing of metals

**Eötvös Loránd University, Faculty of Informatics, Savaria Institute of Technology,
Szombathely, Hungary.**

11.15 Closing Remarks

Each talk includes 12 min of presentation and 3 min of discussion



Abstracts





Automated Control of Machining Processes

Luis Rubio Rodriguez

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Abstract. This work outlines main characteristics of computer controlled machining processes. First, an overview of the control system architecture is given. The developed control system consists of three parts, namely, servo, process and supervisory controllers.

Servo controller follows a predefined trajectory or contouring minimizing errors. Some control algorithms are displayed and compared to this aim. The control algorithms are based on traditional industrial PID and more sophisticated sliding mode controllers.

Process controller can be split, at the same time, in three parts, force controller, vibrations detection and suppression and, tool monitorization for wear estimation. An adaptive control force scheme is addressed. Some algorithms to detect and suppress chatter are also pointed out. Furthermore, a block diagram about tool wear monitorization is presented.

Finally, supervisory control loop is provided. It is based on some external inputs such as process constraints, strategy to follow and required performance indexes. Supervisory control outputs suggestions about tool and process selection, programmed feed rate and speeds, required input commands to the control system, control strategies which have to be performed, and how to manage time-delays in the control system.

Active vibration absorber for aeolian vibration control on suspended cables

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Abstract. The vibration problems in power transmission conductors and cable-supported bridges, significantly affects the strength and durability of cables and may lead to failure of other elements of the structure. Special attention should be paid to the cable oscillation due to wind actions characterized by high frequency and small amplitude, which is called aeolian vibration. Many conventional anti-vibration techniques have been developed and are in current use in the field, such as Stockbridge damper, impact damper, friction damper etc., but there are severe limitations regarding to their implementation and control reliability. Active vibration control techniques have been successfully used in many industrial applications to attenuate the vibration amplitude due to various disturbances; however, only a small number of results can be found in the published literature concerning the problem of active control of cable vibration. This study presents the design of an active vibration absorber system, employing a conventional vibration absorber with actuator and control algorithm, for controlling the vibration of such suspended cables as the transmission line conductor or the cable of cable-stayed bridges. A number of numerical simulations were carried out in the SIMULINK environment using two different control algorithms. One of them is based on PID controller, and the other one estimates cable vibration frequency to determine the dynamic performance of the controller. The simulation results show that both control algorithms lead to a strikingly faster vibration amplitude attenuation than a passive vibration absorber.





Aerodynamic Performance Degradation of Wind Turbine Blades due to Ice Accretion

László E. Kollár

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Abstract. Ice accretion on a 2D section of wind turbine blades is simulated with the specific aim to estimate the aerodynamic performance degradation of the iced blade. The ice accretion model simulates the air flow around the blade, determines the trajectories of water droplets, and calculates the ratio of droplets that freeze on the blade surface. The air flow is then simulated around the iced blade surface, and simulation results provide the lift coefficient and drag coefficient. The ratio of these aerodynamic parameters is compared with the same ratio obtained for the bare blade. This process is repeated for blade shapes with varying camber line, which provides the severity of aerodynamic performance degradation for different blade shapes. The study reveals that the reduction in the lift-to-drag ratio increases as the blade shape approaches the symmetric shape. The consideration of these results in the design process contributes to finding blade shapes that can be used under some icing conditions.

Development of an intelligent vehicle control system

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Abstract. The SZIe-Kart team has needed an easily expandable, robust, high performance control system for the Go-Kart Go-Bosch competition, which is capable to withstand the rough automotive environment. The system had to be flexible enough to solve the complex process control problems. Therefore, I designed a modular system with microcontrollers, where the controllers are communicated through CAN bus. I changed the previously used Arduino based Atmel AVR controllers with Texas Instruments (TI) MCU's. The main aspects of the selection was the better documentation, the built in CAN module, and the TI's own Boosterpack system. The modular design and the use of CAN bus allows to test the modules severally.

For the software development I choose the Energia environment, which allows using the object-oriented C++ language. The benefits of this environment, and language that it's a user friendly quickly learnable method. The high level programming was supported by the TI's Driverlib, what creates a bridge between the object oriented programming and the hardware which makes the software development faster, easier. To implement the function defined by the Bosch, they provided us different sensors. These sensors used CAN bus to provide us with the necessary information. To realize the Driver Assistance (DA) functions we had to add our own sensors too. I had to take these parameter into consideration at the design process. To realize the DA functions in the go-kart I had to design the necessary actuators such as electric gas for the petrol engine, electric brake system, and a power steering. The strict safety regulations made designing these more challenging.

These days making an efficient Human Machine Interface is a high priority task, therefore my goal was to develop a Glass Cockpit (like the airplanes) with touch LCD screens as primary





input, and output device. The competition required a wireless telemetry function. I designed the telemetry primary to send state properties to a distant observation point.

Designing of beam welding technologies for carbon steel structures

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Abstract. This contribution describes the current production process of welding, as the research of technology can only stem from the awareness of the technological features and possibly of what waste could be eliminated in the original situation. The work is focusing on review the current research fields related to the topics of high-pressure welding, classical technology planning process and the conditions of weldability. Particularly, the production technology conditions of crack-free structures, with a special focus on defining the necessary pre-heating temperature, are discussed in detail. For the investigation I used the test results of the laser-hybrid welding. These tests were performed with the professional support of the Crown International Kft - Cloos representative.

Rolling Mill Design Challenges

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Abstract. In forming technologies, the laboratory experimental equipment is more compact as compared to the industrial counterparts. The laboratory facilities are usually produced in smaller series, however, they are designed for a particular purpose and manufactured by specialized companies to meet the needs of a particular research site. Conventional rolling mills are generally suitable only for symmetrical rolling where the circumferential velocity of both cylinders is identical. In the case of asymmetric rolling, the rolls are driven by separate motors to ensure different circumferential velocities.

Current contribution discusses numerous issues related to the design of a rolling mill suitable for both conventional and asymmetric rolling. In the present project planning, it was necessary to account for the main characteristics of conventional constructions, and in view of this, a specific strategy had to be developed, corresponding to a given purpose. Using a mill, which is suitable for asymmetric rolling, it is possible to introduce a large amount of shear deformation into the rolled material, which can be realized by conventional (symmetric) rolling only by employing the cylinders of significantly different roughness or by varying the friction conditions of the upper and lower roll surfaces.





Finite Element Modelling of Deformation Flow In Symmetric And Asymmetric Rolling Processes

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Abstract. Processing technology of metals involves cold rolling, which triggers plastic deformation in a material, subjected to thickness reduction. In the course of symmetric rolling, the compressive component of the three-dimensional deformation tensor is dominating over other ones, whereas, the asymmetric mode accounts for a substantial amount of shear deformation. Additionally, the asymmetric loading is partially caused by both the different friction conditions of the surfaces and the variety in angular velocities of cylinders. This contribution discusses the results of finite element simulation (FEM) of 6063 aluminium alloy subjected to symmetric and asymmetric loading. Ansys Mechanical APDL solver was employed for the FEM calculations. The simulations were performed for non-linear static case, where the roll is considered as a rigid body, whereas the angular velocities of the upper and lower rolls were different with the aim to introduce asymmetry. In this two-dimensional calculation, it was assumed that the material rolled does not suffer any widening. The hexagonal meshing was used, while it appeared that accurate simulation requires a high number of elements through thickness. Therefore, the number of elements across the thickness was varying between 10 and 12. Results of the FEM simulations are presented in a form of strain velocity gradients, strain and stress distributions across the thickness of rolled sheets.

Comparison of microstructure evolution after symmetric and asymmetric rolling

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Abstract. Common manufacturing process of the semi-finished aluminium products is rolling. The product of this process is widely used in automotive and aerospace industry due to the advantage what it offers such as good availability, high corrosion resistance, better strength-to-density ratio, as compared to unalloyed steel grades. Because of the elevating expectations of above-mentioned industries, it is important to perform evaluations related to reduction of the main drawbacks as the poor manufacturability and formability. The key parameters, which determine the formability, reveal a strong relationship with the crystallographic texture.

The texture formation in face-centered cubic materials like aluminium alloys is related to the evolution of several kinds of crystal defects in the dimension range from nm to mm. Presence of a pronounced texture leads to a strong anisotropy, because the deformation spreads in different ways among various crystals, and this limits the practical application of conventional manufacturing processes. This contribution focuses on a comparison between the microstructural changes developed during conventional/symmetrical and non-conventional/asymmetric cold rolling.

The comparison is based on texture examinations, which reveal that during conventional cold rolling a β -fibre texture tends to develop and disappears during the recrystallisation followed





by deformation. The annealing microstructure poses a characteristic texture comprising cube, Goss and P-components. These textures cause low normal anisotropy value in aluminium, which is considered to be undesirable from the point of view of deep drawability. In the case of asymmetric rolling the specimen is subjected to more severe shear deformation, which results in a shear-type texture. Consequently, microstructure evolved after annealing has more appropriate texture for further deep drawing.

Application of polycrystal models to simulation of texture evolution in thermo-mechanical processing of metals

Jurij J. Sidor

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Abstract. Industrially produced metals are usually polycrystalline aggregates with characteristic crystallographic textures. The key microstructural feature such as a grain size is strongly correlated to mechanical properties, however, the anisotropy of properties is mainly affected by means of texture evolved. The evolution of texture occurs over the entire thermo-mechanical processing and the control of this development occurs via tuning of manufacturing parameters. The degree of reduction, number of deformation steps, annealing temperature or heating/cooling rate have a strong impact on both microstructure and texture development. In this view, it is very important to control the key microstructural parameters during each production step and this is possible via linking the external macroscopic influences to the mesoscopic features. The numerical approaches are of great importance in resolving this issue. Current contribution focuses on the implementation of various polycrystal models in prediction of texture evolution in Al alloys during processing. Based on modelling approaches, it is discussed how technological parameters affect both texture evolution and related properties.