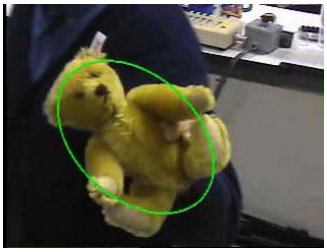
Survey of current research and development

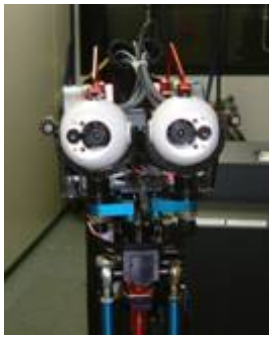
Jožef Stefan Institute, Dept. of Automatics, Biocybernetics, and Robotics

RESEARCH PROJECTS

Modelling, simulation, and control of robotic systems (*Leon Žlajpah)*

Simulation has been recognized as an important tool in designing new products, investigating their performance, and also in designing applications of these products. We have developed an integrated environment for the design of robotic controllers. The main advantage is the flexibility in fast prototyping of different algorithms in the field of robot control, especially for redundant manipulators. The tools are fully integrated in the MATLAB/SIMULINK and hence, a lot of standard tools are available for the analysis and control design. Using the real-time simulation it is possible to apply the developed controllers to a real robot without any additional coding. In our presentation we will show a robot manipulator that can preserve an oscillating motion of an object with playing yo-yo selected as a reference task.





Foveated vision for object recognition on humanoid robots (*Aleš Ude)*

A humanoid vision system that realize foveation using two rigidly connected cameras in each eye will be presented. We developed a fast and responsive oculomotor control system to enable synchronized interpretation of information acquired from peripheral and foveal views. Complex visual processes, which can exploit the properties of foveated vision, were designed to solve difficult problems such as object detection and object recognition in dynamic environments.

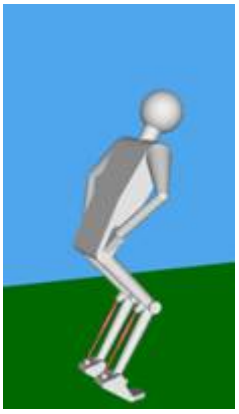
Combined control of a mobile manipulator in unstructured environments (*Damir Omrčen)*

The mobile manipulator consist of a mobile platform and a manipulator arm. The system is controlled by combined control (i.e. the manipulator is controlled by torque and the platform by velocity). We will show that the system is capable of moving in unstructured environments where obstacle avoidance is necessary. Since the system is redundant it can accomplish primary task together with obstacle avoidance.

Robot control based on force and vision sensors (*Leon Lahajnar)*

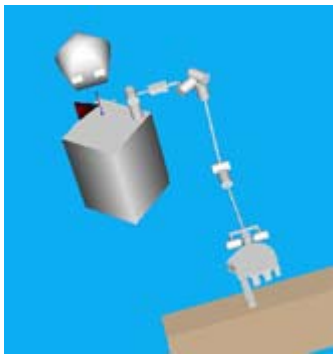
Visual sensors provide the robot with information about the task environment. On the other hand, force sensors are essential to estimate the tool/work piece contact. Our main goal was integrated force/vision robot control that combines advantages of both modalities and reduces their shortcomings. We have developed a system based on sensor fusion which is able to track an unknown trajectory on an unknown surface while maintaining constant contact between the tool and the surface.

Humanoid Jumping Robot Design (*Jan Babič)*



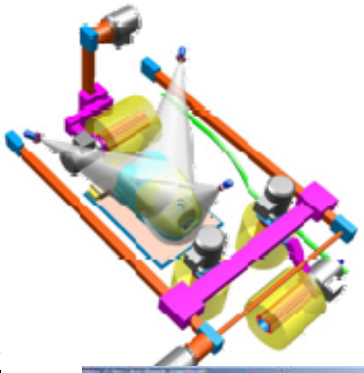
The aim of our research is to build a new human inspired structure of the lower extremity mechanism that will enable a humanoid robot to efficiently perform fast movements such as running and jumping. We started our research by studying the biomechanics of the human vertical jump. Afterwards we built a dynamic model of the humanoid robot and determined the role of the elastic biarticular muscles in performing the vertical jump. To prove our concept and theoretical findings, we are now designing the lower extremity mechanism that will be able to perform the vertical jump.

Human-like arm movement (*Andrej Gams)*



Using a kinematics model of the human arm that includes the shoulder girdle, we implemented an algorithm for mimicking human-like movement. Based on the possibilities of inverse kinematics of a redundant mechanism, the algorithm uses a secondary task that should ensure human-like poses or even movement of the modeled arm. The final goal of the research is to define meaningful criteria for describing human arm movement.

APPLIED RESEARCH AND DEVELOPMENT PROJECTS EXAMPLES



The design of a cleaning manipulator (Anton Ružič)

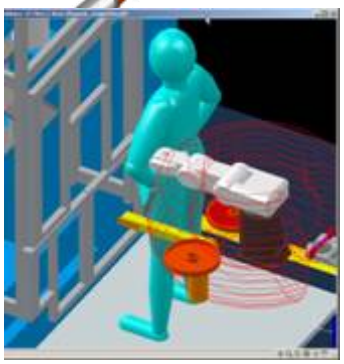
Complete design and development of a prototype cleaning manipulator, including the definition of the cleaning technology.

Cleans oil stains, dust and stains from highly delicate plastic surfaces. Robust solution, adequate for factory environments.

A robot cell for palletizing and quality control of magnets
(Anton Ružič)

Palletizing fragile objects (pressed metal powders) on palettes with varying geometry in a hostile environment.

Simultaneous quality control on manipulated objects (precision 3 microns, 0.1 g).



Supervisory and control system for automated tea production plant (Anton Ružič)

Concurrent production of six different tea products on a single production line that has the size and cost of two or less autonomous production lines.

The supervisory and control system manages all production aspects and is tightly integrated with the factory's production information system.

Shoe lasting machine automation (*Lado Lenart)*

In our laboratory the first known fully automated shoe lasting workstation was setup. It consists of the lasting machine, 6 DOF industrial robot equipped with special gripper and upper and sole positioning device, which consists of nine pneumatic cylinders for fixing and gripping, servo axis for shoe upper positioning, and vision system for determination of the correct positioning of shoe upper and sole.

Automation of finishing operations - EUROShoE project (*Bojan Nemec)*

Finishing operations in shoe manufacturing process require skilled worker and are generally difficult to automate due to the complex motion trajectories. We have designed and realized a cell for finishing operations in a custom shoe production plant. Such customization of shoe production should allow production of small batches of shoes of the same type and requires automatic set up and adaptation of the production line. A CAD system for automatic generation, optimization and validation of motion trajectories was integrated into a robotic cell. In automatic trajectory generation some of the major problems are limitations posed by the robot joint limits, robot singularities and environment obstacles. These problems were solved using the kinematic redundancy of the robot manipulator.

Optoelectronic measurements in biomechanics & electrophysiology in rehabilitation (EU project CARED = Computer Aided Rehabilitation of Respiratory Disabilities) (*Martin Tomšič)*

A significant group of CAL (COPD) patients is involved in a series of experiments designed to elucidate the potentially deleterious role of expiratory muscle contractions during exercise. Standard physiotherapeutic techniques are adopted and the outcome of the rehabilitation is investigated. Specific methods are tested: biofeedback techniques (using EMG monitoring and motion capture system) and electrical neuro-muscular stimulation.

Shoe ergonomics testing (*Igor B. Mekjavič and Nina Kocjan)*

The aim of the following project was to assess the evaporative resistance of footwear during static (standing) and dynamic (walking) conditions. Different levels of sweating and foot skin temperatures were simulated with the Jozef Stefan Institute Thermal Foot Manikin System. Two types of shoes were evaluated; walking (street) shoe and running shoe. We evaluated the footwear microenvironment conditions in the different conditions.