

---

# Editorial

---

This Special Issue contains a selection of papers from the IMEKO TC-17 *International Symposium on Measurements and Control in Robotics ISMCR'2007*, extended and significantly improved over conference proceeding's version of the papers. There are ten papers in this Special Issue, containing a range of topics of the Measurements and Control in Robotics area.

The first paper titled *Vision - Based Mobile Robot Navigation* written by Sid Ahmed Berrabah and Eric Colon presents a vision-based navigation system for mobile robots. It enables the robot to build a map of its environment, localize efficiently itself without any artificial markers or other modification, and navigate without colliding with obstacles. The Simultaneous Localization And Mapping (SLAM) procedure builds a global representation of the environment based on several size limited local maps built using the approach introduced by Davison *et al.* Two methods for global map are presented; the first method consists in transforming each local map into a global frame before to start building a new local map. While in the second method, the global map consists only in a set of robot positions where new local maps are started (i.e. the base references of the local maps). Based on the estimated map and its global position, the robot can find a path and navigate without colliding with obstacles to reach a user-defined goal. The moving objects in the scene are detected and their motion is estimated using a combination of Gaussian Mixture Model (GMM) background subtraction approach and a Maximum a Posteriori Probability Markov Random Field (MAP-MRF) framework. Experimental results in real scenes are presented to illustrate the effectiveness of the proposed method.

The second paper titled *Dense 3D Structure and Motion Estimation as an aid for Robot Navigation* by Geert De Cubber presents three-dimensional scene reconstruction as an important tool in many applications varying from computer graphics to mobile robot navigation. In this paper author focuses on the robotics application, where the goal is to estimate the 3D rigid motion of a mobile robot and to reconstruct a dense three-dimensional scene representation. The reconstruction problem can be subdivided into a number of sub problems. First, the egomotion has to be estimated. For this, the camera (or robot) motion parameters are iteratively estimated by reconstruction of the epipolar geometry. Secondly, a dense depth map is calculated by fusing sparse depth information from point features and dense motion information from the optical flow in a variational framework. This depth map corresponds to a point cloud in 3D space, which can then be converted into a model to extract information for the robot navigation algorithm. Here, an integrated approach for the structure and egomotion estimation problem has been presented.

The third paper titled *A Behaviour - based Control and Software Architecture for the Visually Guided Robudem* outdoor mobile robot written by Daniela Doroftei, Eric Colon and Geert De Cubber presents the design of outdoor autonomous robots, requiring the careful consideration and integration of multiple aspects: sensors and sensor data fusion, design of a control and software architecture, design of a path planning algorithm and robot control. This paper describes partial aspects of this research work, which is aimed at developing a semi-autonomous outdoor robot for risky interventions. The authors focuses mainly on three main aspects of the design process: visual sensing using stereo - vision and image motion analysis, design of a behaviour -based control architecture and implementation of a modular software architecture.

I. Ion, A. Marin, A. Curaj and L. Vladareanu contributed a paper titled *Design and Motion Synthesis of Modular Walking Robot Mero*. This paper describes the walking robots, which are built to displace the loads on the not-aligned terrain. The mechatronic walking system protect much better the environment when its contact with the soil is discrete, a fact that limits the area that is crushed appreciatively. This walking robot has three two-legged modules. Every leg has three freedom degrees and a tactile sensor to measure the contact, which consists of the lower and upper levels. The body of the walking robot carries a gyroscopic bearing sensor to measure the pitch and roll angles of the platform. The legs are powered by hydraulic drives and are equipped with potentiometric sensors, which are used to control the walking robot in the adaptability to a natural ground.

Dzmitry Tsetserukou, Hiroyuki Kajimoto, Naoki Kawakami and Susumu Tachi contributed a paper titled *Safe Reaction of a Robot Arm with Torque Sensing Ability on the External Disturbance and Impact: Implementation of a New Variable Impedance Control*. The paper focuses on control of a new anthropomorphic robot arm enabling the torque measurement in each joint to ensure safety while performing tasks of physical interaction with human and environment. A novel variable control strategy was elaborated to increase the robot functionality and to achieve human-like dynamics of interaction. The algorithm of impact control imparting reflex action ability to the robot arm was proposed. The experimental results showed successful recognition and realization of three different types of interaction: service task, co-operative task, and impact state.

The sixth paper, by Hyunki Lee, Min Young Kim and Hyungsuck Cho, describes *A New 3D Sensor System by Using Virtual Camera Model and Stereo Vision for Mobile Robots*. Intelligent autonomous mobile robots must be able to sense and recognize 3D indoor space where they live or work. So many researches have been conducted to develop 3D sensing method for mobile robots. Among them, the optical triangulation, a well-known method for 3D shape measurement, is also based on active vision sensing principle for mobile robot sensor system, so that the measurement result is robust to illumination noises from environments. Due to this advantage it has been popularly used. However, to obtain the 3D information of environment it needs a special scanning process and scanning actuators need. To omit this scanning process multi-line projection methods have been widely researched. However, they suffer from an inherent limitation: The results of multi-line projection method commonly have measurement errors because of  $2\pi$ -ambiguity caused by regularly repeated multi-line laser pattern. In this paper, to overcome  $2\pi$ -ambiguity effectively, the authors introduce a novel sensing method for a 3D sensing system using multi-line projection and stereo cameras, based on the virtual camera model and stereovision algorithm. To verify the efficiency and accuracy of the proposed method, a series of experimental tests were performed.

Another example of sensing methods is presented in the paper titled *Development of a Stabilized Wideband Pendulum-type Gravity Direction Sensor Utilizing an Electromagnetic Clutch and Brake for Anti-Swing* authored by Tokuji Okada, Akihiro Tsuchida, Tomofumi Mukaiyachi and Toshime Shimizu. This paper proposes the usefulness of combining an electromagnetic clutch and brake with a pendulum for anti-swing for developing a stabilized wideband pendulum-type gravity direction sensor. The pendulum-type sensor is high in response to direction change but liable to swing even when the change stops, in general. Therefore, anti-swing control without degrading sensitivity of direction measurement is important. Continuous damping of the pendulum motion causes an error in a stationary condition unless the pendulum is free from damping repetitively in an appropriate term. To develop a quick response direction sensor without error, the authors use a magnetic device. Based on motion analysis of a double pendulum, they simulate behaviours of the pendulum-type sensor by actuating the magnetic device by using different signals in form, frequency and magnitude. In the experiment it has been demonstrated that the device is beneficial for suppressing pendulum vibration over a wideband for measuring resultant direction of the acceleration compound with motion and gravity on such a platform moving randomly.

Next paper titled *Parallel Robot Motion Applied To Flight Simulator Control Law Synthesis* written by Cezary J. Szczepański describes a method of synthesis of the parallel robot applied as flight simulator motion system control laws came from author's 20 year experience in developing, integrating and testing the control laws and their software dedicated to different simulators. The goal of the simulator motion control law synthesis at the proposed method is not minimizing a cost function taken a priori at the beginning of that synthesis process but achieving positive assessment by the operator (e.g. pilot) team on the basis of simulator motion perception. Procedures adopted for those simulators FAT (Final Acceptance Tests) within proposed method were based on standard military equipment testing methods. Performing the final and the most important tests by the real device operators (pilots) was the new element here. The other important modification of the classical method was introducing the simulated object acceleration derivative into the filters controlling the simulator motion system. It appeared to be particularly effective in the cases of highly maneuverable airplane simulators.

The ninth paper titled *Methods for Classification of Tactile Patterns in General Position by Helmholtz's Equation* co-authored by Jaromír Volf, Martin Dvořák and Josef Vlček describes new and original methods of tactile pattern recognition in general position applying the solution of Helmholtz's equation for a tactile transducer. Three groups of methods have been formed, based on: calculation of the A matrix eigen value, with the matrix being formed either from the whole pattern, or from the limit points; the scalar characteristic distribution of the components of the pattern's A matrix; and the geometrical properties of the A matrix of the pattern.

---

Finally, the paper titled *A Hybrid System Control Approach to Biped Robot Control* submitted by Yingjie Yin and Shigeyuki Hosoe review the state of the art of biped motion control in the field of hybrid system control. The main motivation is to fix the understanding of the research field and clarify strong and weak points of the available approaches. The presentation is illustrated by a typical example of biped machines.

I am grateful for the efforts and willing collaboration of authors who helped to improve the quality of papers and the value of this special issue.

**Professor Andrzej Małowski**

Member of IMEKO Technical Committee 17

Executive Chairman of the ISMCR' 2007

October of 2008