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# Editorial

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## ROBOT PERCEPTION

Robotics is about intelligent connection of perception to action. Perception is the result of observation, i.e. sensing or technically speaking a measurement that leads to the comprehension of the robot's surroundings or their state. Perception of the environment is of paramount importance to the functioning of robots, especially in semi-structured and unstructured dynamic environments. It is the foundation on which robot actions are based, starting from obstacle detection for the purpose of navigation and ending with object recognition for the purpose of understanding the ontological context in which those actions are to be performed. This issue of *Journal of Automation, Mobile Robotics and Intelligent Systems* collects papers devoted to different aspects of robot perception. This collection is composed of 10 papers. They deal with:

- diverse sensors providing perceptual data,
- methods of sensoric data processing leading to object and scene recognition,
- utilization of ontologies in the process of deriving meaning from the observed data,
- methods of sensoric data processing for the purpose of robot control,
- use of the results of perception in control of robots.

The first group of 5 papers traverses the subjects associated with perception beginning with senses (here olfactory and visual), going through methods of processing the obtained data and ending with understanding its semantics, so that it can be used for decision making or control. The next two papers are devoted to perception employed in grasping used both in telemanipulated and autonomous robots. Subsequent two papers deal with proprioception employed for walking machine control. The last paper assumes that the perception of the environment in the form of a map is already available to the robot and focuses on motion planning in environments containing obstacles. The following text provides a concise insight into the contents of each of those papers.

The paper entitled *Chemical Scanner for Mobile Robot Navigation*, authored by Piotr Batog and Andrzej Wołczowski, focuses on the design and use of an olfactory sensor, i.e. artificial sense of smell. The proposed sensor detects odour gradient, which in turn can be used for mobile robot navigation. The sensor exhibits increased sensitivity to odours due to internally induced gas flow. The characteristics of the sensor obtained experimentally are presented comprehensibly and compared with the simulation results based on theoretical considerations.

The paper entitled *Perceptual Colour Correlogram and Perception-based Statistical Features of Colour Texture*, by Konrad Bojar, introduces the perceptual colour correlogram, generalizing the concept of the spatial grey-level dependency matrix to the case of colour textures. The paper extends Haralik's features extracted from a grey-level image in such a way as to apply them to texture classification in colour images. For that purpose perceptual colour differences are used. The proposed approach enhances robot capabilities of recognising objects in real cluttered environments. The experiments were conducted on floor carpets with different degree of wear.

An analysis of two open source libraries, namely Microsoft Kinect SDK and OpenNI coupled with NiTE, is conducted in the paper entitled *RGB-D Sensors in Social Robotics*, authored by Michał Dziergwa, Paweł Kaczmarek and Jan Kędziński. The focus is on the time needed to detect a person, the accuracy of establishing his/her position and orientation, as well as the stability of the tracking process. Those parameters are important from the point of view of utilising those libraries to design perception subsystems for social robots.

The authors: Barbara Siemiątkowska, Bogdan Harasymowicz-Boggio and Łukasz Chechliński in their paper entitled *Semantic Place Labeling Method* discuss the utilisation of a Sick laser scanner and a Kinect RGB-D sensor in object recognition. Dempster-Shafer theory was employed to infer the type of the encountered room based on its contents. For example, a wash basin is probably in a toilet rather than in an office. By using the results of recognition the robot is able to deduce the type of the room it is currently located in. Thus, a semantic localisation is performed. The paper establishes a direct link between percepts and higher-level ontological concepts what enables the deduction of the purpose of the room, thus classifying it.

The paper: *Architecture for an Autonomous Robot at the IT Level*, authored by Stanisław Ambroszkiewicz, Waldemar Bartyna, Kamil Skarżyński, Marcin Stępniać and Maciej Szymczakowski, presents ontology for describing buildings and their contents. The instances of that ontology are utilised by a robot control system structured as a Service Oriented Architecture. Execution of a service requires the elaboration of a plan composed of elementary actions defined in terms of the concepts present in the ontology. Perception is utilised to ascertain whether the plan is

executed as expected, otherwise an exception has to be handled, usually requiring an update of the state of the environment model contained in the system repository and replanning. The proposed approach has been verified in a simulation environment.

Igor Zubrycki and Grzegorz Granosik authored the paper *Intuitive User Interfaces for Mobile Manipulation Tasks*, in which they present the development of a human-machine interface to gesture-based control of grippers attached to telemanipulators. The paper focuses on the perception of the human hand motions which are subsequently translated into gripper motion commands. To perceive the hand gestures the sensor glove, Kinect and Leap Motion sensors have been used. As some of the grippers have a different kinematic structure than that of a human hand the mapping of the motion of the latter into that of the former is not a straightforward task.

Wojciech Szykiewicz in his paper entitled *Robot Grasp Synthesis Under Object Pose Uncertainty* discusses the problem of grasping objects with the shape that can be approximated by superquadrics, thus significantly reducing the number of shape parameters. The parameters of those superquadrics have to be obtained from the perception subsystem. Then a grasp appropriate for that object can be planned. The position and orientation of the grasped object can be estimated by cameras, however even then some uncertainty as to its pose remains, thus this fact has to be taken into account in the planning process. Dynamic simulation taking into account pose uncertainty, object shape modelling by superquadrics and three measures of grasp quality have been used in grasp synthesis for a manipulator equipped with a three-fingered gripper containing touch sensors.

Marek Wąsik in the paper entitled *Leg's Tip-Ground Contact Detection Based on Drive Currents in a Real Walking Robot* considers the problem of contact detection between the ground surface and the walking robot leg tip. In this case a proprioceptive input is formed by the measurement of total current drawn by the servomotors of each leg. Detection of leg contact with the ground is essential for proper control of walking. The proposed control method was verified on a 5-legged walking machine. The proposed impact detection method has been tested for different gait patterns and diverse parameters of motion.

The paper *The Role of Compliant Elements in Two-Legged Robot's Foot Model*, authored by Magdalena Sylwia Żurawska, Teresa Zielińska and Maksymilian Szumowski investigates the influence of the parameters of dampers and springs mounted in each foot of a biped on its postural stability. The proper choice of the parameters of these passive elements improves the postural stability and as a result reduces the need for the compensatory swaying of the robot's body. The analysis of stability was based on the Zero Moment Point (ZMP) method. This work shows that the control algorithm can be significantly simplified, if the limbs of the robot are adequately designed. The implementation of the ZMP based control method requires a proprioceptive input from force sensors located in the feet of the biped. This is an example showing how adequate design of a mechanism can aid proprioception in devising appropriate control of the biped's gait.

Tomasz Gawron and Maciej M. Michałek in their paper entitled *Planning the Waypoint-Following Task for a Unicycle-Like Robot in Cluttered Environments* investigate the problem of motion planning in cluttered environments. A unicycle type of mobile robot is the subject of control. First the A\* search algorithm is used to find a safe path to the goal in a cluttered environment, which is represented as a two-dimensional occupancy grid. This map is obtained by perceiving the real environment. The obtained path is then supplemented with robot orientations in the selected waypoints. For such an enhanced path the Vector Field Orientation control method is used to drive the robot to the goal. The proposed motion planning method has been verified by simulation experiments.

All of the enumerated topics are at the forefront of the currently ongoing research into robot perception. Each of the papers gives a valuable insight into a particular problem, providing its formulation and deriving a solution. This selection of papers reveals the wide scope and diversity of contemporary research conducted on robot perception.

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