Special issue on selected papers from Robotics: Science and Systems 2010

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This issue of *Autonomous Robots* is the second of two special journal issues compiled from selected papers presented at the sixth Robotics: Science and Systems (RSS) Conference, held at the Universidad de Zaragoza, Zaragoza, Spain in June 2010. The first special issue was recently published by the *International Journal of Robotics Research*. RSS is a single-track conference, with the aim of bringing together researchers from all areas of robotics, showcasing the most recent and significant advances in the field, and providing a forum for academic discourse for the robotics community.

The conference brought together 315 researchers from academic institutions and industry from around the world. The conference program featured 40 papers, each carefully chosen in a rigorous review process from 239 submissions, four invited talks by leading scientists from research fields related or relevant to robotics, and two Early Career Spotlight Presentations by promising young researchers from our community. The technical program covered a wide range of research areas, including control, sensing, perception, manipulation, mechanical design, actuation, machine learning, motion planning, probabilistic robotics, and planning. The presentations addressed an equally broad range of robot types, including swimming, diving, driving, and flying robots, as well as many application areas, including autonomous driving, exoskeletons, mobile manipulation, and molecular biology.

The broad scope of the conference is reflected in the papers selected for this volume. The papers present a novel

mechanism for insect-scale flapping wing mechanisms, examine and highlight the importance of grasp synergies in achieving high-quality grasps, address the integration of tactile information into grasp planning in manipulation, describe a novel lane estimation algorithm for autonomous driving, and present a method for color-accurate underwater imaging.

The first paper, entitled “Passive torque regulation in an underactuated flapping wing robotic insect” and authored by Sreetharan and Wood, presents progress towards airborne flapping-wing robots at the millimeter scale. The authors describe a novel wing flapping mechanism, driven by a single piezoelectric actuator. The mechanism, in spite of having only a single actuator, can generate a flapping motion of the wings that passively varies the angle of attack of the wings. This is variation necessary for creating lift—a precondition for flight. Indeed, measurements performed with the prototype demonstrate that the mechanism generates lift. Interestingly, the resulting wing trajectories are similar to those observed in biological insects. Clearly, the ability to generate lift is an important step towards the realization of small wing-flapping airborne robots.

The second paper, entitled “On the role of hand synergies in the optimal choice of grasping forces,” by Gabbicini, Bicchi, Prattichizzo, and Malvezzi, addresses an important open question in human and robotic grasping. Human pre-grasp motions span only a low-dimensional subspace of the hand’s overall configuration space. The lower-dimensional space corresponds to postural synergies that couple many of the kinematic degrees of freedom to perform a coordinated motion. The paper for the first time establishes a connection between these postural synergies and force closure properties of grasps. The presented simulation study demonstrates that these postural synergies are also critical for the generation of high-quality force closure grasps. This insight may

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lead to novel hand designs and associated control algorithms for grasping.

The third paper, entitled “Robust grasping under object pose uncertainty” and authored by Hsiao, Kaelbling, and Lozano-Pérez, presents a decision-theoretic approach that uses tactile sensors to achieve precise localization of a robot’s hand relative to an object to be grasped. The authors describe a POMDP-based algorithm that generates sensing actions; the resulting observations are integrated into the current believe state. The algorithm’s computational efficiency is based on the efficient pruning of the overall search space. The experimental evaluation shows that once a precise positioning of the hand relative to the object has been achieved, a predetermined grasp can successfully be executed on a real robotic system. The paper demonstrates in an impressive manner that tactile sensing, when coupled with appropriate planning and reasoning, can greatly facilitate manipulation in unstructured environments.

The fourth paper, entitled “Probabilistic lane estimation for autonomous driving using basis curves” and authored by Huang and Teller, proposes an elegant way of performing lane estimation and tracking for autonomous driving. A pivotal component of the algorithm is the principled manner in which similar curves can be described as variations of a basis curve. This enables the algorithm to perform robust lane

estimate on multi-lane roads without making assumptions about the vehicle’s orientation relative to the lane. The authors implemented their algorithm on a vehicle and present an extensive empirical evaluation for 44 kilometers of roadway.

The final paper, entitled “Color-accurate underwater imaging using perceptual adaptive illumination” and authored by Vasilescu, Detweiler, and Rus, presents a method for color-accurate imaging under water. The attenuation of light passing through water heavily changes hues towards blue. Yet the accurate perception of color is important for many underwater applications, including environmental monitoring and marine biology. The paper describes a novel instrument and associated algorithms for the acquisition of color-accurate image under water. Based on knowledge of the distance to the perceived objects, the effect of attenuation can be compensated. To validate the proposed perception system, the authors took an underwater robot equipped with the device to three coral reefs, in addition to tests in an artificial pool. The resulting images are visually stunning and enable new color-based analyses of underwater life.

We hope you will enjoy reading these papers!

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