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Biophysical Journal

Vol. 109, no. 5
Nothing of interest.

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Proceedings of the National Academy of Sciences, USA

vol. 112, no. 35,36,37,38,39
Nothing of interest.

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Review of Scientific Instruments

vol. 86, no. 9

Nothing of interest

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IEEE Transactions on Automatic Control
vol. 60, no. 10

Nothing of interest.

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Deep and high-resolution three-dimensional tracking of single particles using nonlinear and multiplexed illumination

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Molecular trafficking within cells, tissues and engineered three-dimensional multicellular models is critical to the understanding of the development and treatment of various diseases including cancer. However, current tracking methods are either confined to two dimensions or limited to an interrogation depth of ~15 μm. Here we present a three-dimensional tracking method capable of quantifying rapid molecular transport dynamics in highly scattering environments at depths up to 200 μm. The system has a response time of 1 ms with a temporal resolution down to 50 μs in high signal-to-noise conditions, and a spatial localization precision as good as 35 nm. Built on spatiotemporally multiplexed two-photon excitation, this approach requires only one detector for three-dimensional particle tracking and allows for two-photon, multicolour imaging. Here we demonstrate three-dimensional tracking of epidermal growth factor receptor complexes at a depth of ~100 μm in tumour spheroids.

IEEE Transactions on Signal Processing (Issue 18, 19, 2015)

IEEE/ASME Transactions on Mechatronics (Issue 3, 2015)

IEEE Transactions on Image Processing (Issue 10, 11, 2015)

RSSI-Based Multi-Target Tracking by Cooperative Agents Using Fusion of Cross-Target Information

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Abstract
In this paper we present a new approach to Received-Signal-Strength-Indicator (RSSI)-based multi-target tracking. In order to effectively deal with this inherently high-dimensional problem, the approach leverages space decomposition through cooperative distributed processing. The core system is composed of multiple agents where each agent is assigned to track a particular target. The agents exchange information, and based on it they treat the RSSI from the targets they do not track as measurement interference. We present computer simulations that compare the new method with conventional approaches in settings with two and 20 targets, respectively. They demonstrate the improvements of the proposed method in tracking a relatively large number of targets.

Dynamic Screening: Accelerating First-Order Algorithms for the Lasso and Group-Lasso

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Abstract
Recent computational strategies based on screening tests have been proposed to accelerate algorithms addressing penalized sparse regression problems such as the Lasso. Such approaches build upon the idea that it is worth dedicating some small computational effort to locate inactive atoms and remove them from the dictionary in a preprocessing stage so that the regression algorithm working with a smaller dictionary will then converge faster to the solution of the initial problem. We believe that there is an even more efficient way to screen the dictionary and obtain a greater acceleration: inside each iteration of the regression algorithm, one may take advantage of the algorithm computations to obtain a new screening test for free with increasing screening effects along the iterations. The dictionary is henceforth dynamically screened instead of being screened statically, once and for all, before the first iteration. We formalize this dynamic screening principle in a general algorithmic scheme and apply it by embedding inside a number of first-order algorithms adapted existing screening tests to solve the Lasso or new screening tests to solve the Group-Lasso. Computational gains are assessed in a large set of experiments on synthetic data as well as real-world sounds and images. They show both the screening efficiency and the gain in terms of running times.

Block-Sparsity-Induced Adaptive Filter for Multi-Clustering System Identification

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Abstract
In order to improve the performance of least mean square (LMS)-based adaptive filtering for identifying block-sparse systems, a new adaptive algorithm called block-sparse LMS (BS-LMS) is proposed in this paper. The basis of the proposed algorithm is to insert a penalty of block-sparsity, which is a mixed l2, 0 norm of adaptive tap-weights with equal group partition sizes, into the cost function of traditional LMS algorithm. To describe a block-sparse system response, we first propose a Markov-Gaussian model, which can generate a kind of system responses of arbitrary average sparsity and arbitrary average block length using given parameters. Then we present theoretical expressions of the steady-state misadjustment and transient convergence behavior of BS-LMS with an appropriate group partition size for white Gaussian input data. Based on the above results, we theoretically demonstrate that BS-LMS has much better convergence behavior than l0-LMS with the same small level of misadjustment. Finally, numerical experiments verify that all of the theoretical analysis agrees well with simulation results in a large range of parameters.

Orthogonal Matching Pursuit With Thresholding and its Application in Compressive Sensing
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Abstract
Greed is good. However, the tighter you squeeze, the less you have. In this paper, a less greedy algorithm for sparse signal reconstruction in compressive sensing, named orthogonal matching pursuit with thresholding is studied. Using the global 2-coherence, which provides a ?bridge? between the well known mutual coherence and the restricted isometry constant, the performance of orthogonal matching pursuit with thresholding is analyzed and more general results for sparse signal reconstruction are obtained. It is also shown that given the same assumption on the coherence index and the restricted isometry constant as required for orthogonal matching pursuit, the thresholding variation gives exactly the same reconstruction performance with significantly less complexity.

Probabilistic Approach to Modeling and Parameter Learning of Indirect Drive Robots From Incomplete Data
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Abstract
This paper deals with the problem of modeling and identification for industrial robots with indirect drive mechanisms (e.g., gear transmissions), where the motor-side behavior may deviate from the load-side (i.e., end effector) behavior due to the robot joint dynamics. In this case, the motor-side sensors alone are not sufficient for directly obtaining the load-side behavior. We call such problems incomplete data problems since some key information (i.e., the load-side behaviors) is missing during the identification process. This paper, thus, presents a procedure for identifying robot models even with limited load-side information. It begins by describing the relationship between the missing information and the available measurements using a Gaussian dynamic model. Then, the expectation-maximization algorithm is applied to handle the parameter estimation problem in the presence of missing information. Various relaxation techniques are utilized to alleviate the computational complexity of the algorithm. The effectiveness of the proposed method is demonstrated on three real-world problems in industrial automation, namely the gain tuning of the Kalman filter, the friction identification, and the self-calibration of load-side inertial sensors.

Online Multi-Target Tracking With Unified Handling of Complex Scenarios
Huaizu Jiang ; Jinjun Wang ; Yihong Gong ; Na Rong ; Zhenhua Chai ; Nanning Zheng

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Abstract
Complex scenarios, including miss detections, occlusions, false detections, and trajectory terminations, make the data association challenging. In this paper, we propose an online tracking-by-detection method to track multiple targets with unified handling of aforementioned complex scenarios, where current detection responses are linked to the previous trajectories. We introduce a dummy node to each trajectory to allow it to temporally disappear. If a trajectory fails to find its matching detection, it will be linked to its corresponding dummy node until the emergence of its matching detection. Source nodes are also incorporated to account for the entrance of new targets. The standard Hungarian algorithm, extended by the dummy nodes, can be exploited to solve the online data association implicitly in a global manner, although it is formulated between two consecutive frames. Moreover, as dummy nodes tend to accumulate in a fake or disappeared trajectory while they only occasionally appear in a real trajectory, we can deal with false detections and trajectory terminations by simply checking the number of consecutive dummy nodes. Our approach works on a single, uncalibrated camera, and requires neither scene prior knowledge nor explicit occlusion reasoning, running at 132 frames/s on the PETS09-S2L1 benchmark sequence. The experimental results validate the effectiveness of the dummy nodes in complex scenarios and show that our proposed approach is robust against false detections and miss detections. Quantitative comparisons with other methods on five benchmark sequences demonstrate that we can achieve comparable results with the most existing offline methods and better results than other online algorithms.

Color Sparse Representations for Image Processing: Review, Models, and Prospects

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Abstract
Sparse representations have been extended to deal with color images composed of three channels. A review of dictionary-learning-based sparse representations for color images is made here, detailing the differences between the models, and comparing their results on the real and simulated data. These models are considered in a unifying framework that is based on the degrees of freedom of the linear filtering/transformation of the color channels. Moreover, this allows it to be shown that the scalar quaternionic linear model is equivalent to constrained matrix-based color filtering, which highlights the filtering implicitly applied through this model. Based on this reformulation, the new color filtering model is introduced, using unconstrained filters. In this model, spatial morphologies of color images are encoded by atoms, and colors are encoded by color filters. Color variability is no longer captured in increasing the dictionary size, but with color filters, this gives an efficient color representation.

Video Inpainting With Short-Term Windows: Application to Object Removal and Error Concealment

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Abstract
In this paper, we propose a new video inpainting method which applies to both static or free-moving camera videos. The method can be used for object removal, error concealment, and background reconstruction applications. To limit the computational time, a frame is inpainted by considering a small number of neighboring pictures which are grouped into a group of pictures (GoP). More specifically, to inpaint a frame, the method starts by aligning all the frames of the GoP. This is achieved by a region-based homography computation method which allows us to strengthen the spatial consistency of aligned frames. Then, from the stack of aligned frames, an energy function based on both spatial and temporal coherency terms is globally minimized. This energy function is efficient enough to provide high quality results even when the number of pictures in the GoP

is rather small, e.g. 20 neighboring frames. This drastically reduces the algorithm complexity and makes the approach well suited for near real-time video editing applications as well as for loss concealment applications. Experiments with several challenging video sequences show that the proposed method provides visually pleasing results for object removal, error concealment, and background reconstruction context.

Optics Express

Volume 23, Issue 18

Fast and simple spectral FLIM for biochemical and medical imaging
Marina Popleteeva, Kalina T. Haas, David Stoppa, Lucio Pancheri, Leonardo Gasparini, Clemens F. Kaminski, Liam D. Cassidy, Ashok R. Venkitaraman, and Alessandro Esposito
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Spectrally resolved fluorescence lifetime imaging microscopy (λFLIM) has powerful potential for biochemical and medical imaging applications. However, long acquisition times, low spectral resolution and complexity of λFLIM often narrow its use to specialized laboratories. Therefore, we demonstrate here a simple spectral FLIM based on a solid-state detector array providing in-pixel histrogramming and delivering faster acquisition, larger dynamic range, and higher spectral elements than state-of-the-art λFLIM. We successfully apply this novel microscopy system to biochemical and medical imaging demonstrating that solid-state detectors are a key strategic technology to enable complex assays in biomedical laboratories and the clinic.

Long-distance super-resolution imaging assisted by enhanced spatial Fourier transform
Heng-He Tang and Pu-Kun Liu
Peking University, China

A new gradient-index (GRIN) lens that can realize enhanced spatial Fourier transform (FT) over optically long distances is demonstrated. By using an anisotropic GRIN metamaterial with hyperbolic dispersion, evanescent wave in free space can be transformed into propagating wave in the metamaterial and then focused outside due to negative-refraction. Both the results based on the ray tracing and the finite element simulation show that the spatial frequency bandwidth of the spatial FT can be extended to $2.7k_0$ (k_0 is the wave vector in free space). Furthermore, assisted by the enhanced spatial FT, a new long-distance (in the optical far-field region) super-resolution imaging scheme is also proposed and the super resolved capability of $\lambda/5$ (λ is the wavelength in free space) is verified. The work may provide technical support for designing new-type high-speed microscopes with long working distances.

Real-time adaptive drift correction for super-resolution localization microscopy
Ginni Grover, Wyatt Mohrman, and Rafael Piestun
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Super-resolution localization microscopy involves acquiring thousands of image frames of sparse collections of single molecules in the sample. The long acquisition time makes the imaging setup prone to drift, affecting accuracy and precision. Localization accuracy is generally improved by a posteriori drift correction. However, localization precision lost due to sample drifting out of focus cannot be recovered as the signal is originally detected at a lower peak signal. Here, we demonstrate a method of stabilizing a super-resolution localization microscope in three dimensions for extended periods of time with nanometer precision. Hence, no localization correction after the experiment is required to obtain super-resolved reconstructions. The method incorporates a closed-loop with a feedback signal generated from camera images and actuation on a 3D nanopositioning stage holding the sample.

Volume 23, Issue 19

Nothing of interest.

Physical Review E

Volume 92, Issue 3

Looking at a blinking quantum emitter through time slots: The effect of blind times
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Most experimental observations of physical processes are naturally accompanied by “blind” (“dead”) times, which in principle can distort the result of measurements. Here we analyze how the presence of blind times in measurements changes the measured statistics of blinking fluorescence of single quantum dots. We show that information can be extracted even for blinking processes with characteristic times longer than both blind times and time slots between them.

Optimal control of overdamped systems
Patrick R. Zulkowski and Michael R. DeWeese
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Nonequilibrium physics encompasses a broad range of natural and synthetic small-scale systems. Optimizing transitions of such systems will be crucial for the development of nanoscale technologies and may reveal the physical principles underlying biological processes at the molecular level. Recent work has demonstrated that when a thermodynamic system is driven away from equilibrium then the space of controllable parameters has a Riemannian geometry induced by a generalized inverse diffusion tensor. We derive a simple, compact expression for the inverse diffusion tensor that depends solely on equilibrium information for a broad class of potentials. We use this formula to compute the minimal dissipation for two model systems relevant to small-scale information processing and biological molecular motors. In the first model, we optimally erase a single classical bit of information modeled by an overdamped particle in a smooth double-well potential. In the second model, we find the minimal dissipation of a simple molecular motor model coupled to an optical trap. In both models, we find that the minimal dissipation for the optimal protocol of duration τ is proportional to $1/\tau$, as expected, though the dissipation for the erasure model takes a different form than what we found previously for a similar system.

2015 Conference on Information Fusion

Langevin Monte Carlo filtering for target tracking

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This paper introduces the Langevin Monte Carlo Filter (LMCF), a particle filter with a Markov chain Monte Carlo algorithm which draws proposals by simulating Hamiltonian dynamics. This approach is well suited to non-linear filtering problems in high dimensional state spaces where the bootstrap filter requires an impracticably large number of particles. The simulation of Hamiltonian dynamics is motivated by leveraging more model knowledge in the proposal design. In particular, the gradient of the posterior energy function is used to draw new samples with high probability of acceptance. Furthermore, the introduction of auxiliary variables (the so-called momenta) ensures that new samples do not collapse at a single mode of the posterior density. In comparison with random-walk Metropolis, the LMC algorithm has been proven more efficient as the state dimension increases. Therefore, we are able to verify through experiments that our LMCF is able to attain multi-target tracking using small number of particles when other MCMC-based particle filters relying on random-walk Metropolis require a considerably larger particle number. As a conclusion, we claim that performing little additional work for each particle (in our case, computing likelihood energy gradients) turns out to be very effective as it allows to greatly reduce the number of particles while improving tracking performance.

Mechatronics (Volume 29)

Modeling, design, and implementation of a baton robot with double-action inertial actuation *Pages 1-12*

Joe Zoghzoghy, Junkai Zhao, Yildirim Hurmuzlu

Abstract

In this paper, we present a baton locomotor capable of generating tapping gait. A baton is a system that consists of two masses joined with a massless rod. We use a new double-action inertial actuation scheme to drive this system. This scheme employs two spinning pendulums at one end, turning in opposite directions with the same angular velocity. One can control the direction and magnitude of the resultant inertial force that propels the system by changing the rendez-vous angle and the angular velocity of the spinners. In this paper, we first present the modeling of the system with actuation on both ends. Then, we use a numerical approach to simulate and analyze the tapping gait of the inertially actuated baton. In addition, we developed a new prototype, Pony II robot, to establish the practicality of the concept. This prototype consists of the double-action spinners mounted on both ends of the baton. The mechanical and electronic components of the robot are also presented in full detail. Finally, we demonstrate that the robot can successfully generate periodic tapping gait.

Plus One

Journal of Process Control (Volume 35)

Minimal unknown-input functional observers for multi-input multi-output LTI systems *Pages 143-153*

Reza Mohajerpoor, Hamid Abdi, Saeid Nahavandi

Abstract

Designing minimum possible order (*minimal*) disturbance-decoupled proper functional observers for multi-input multi-output (MIMO) linear time-invariant (LTI) systems is studied. It is *not* necessary that a minimum-order unknown-input functional observer (UIFO) exists in our proposed design procedure. If the minimum-order observer cannot be attained, the observer's order is increased sequentially through a recursive algorithm, so that the minimal order UIFO can be obtained. To the best of our knowledge, this is the first time that this specific problem is addressed. It is assumed that the system is *unknown-input functional detectable*, which is the least requirement for the existence of a stable UIFO. This condition also is a certificate for the convergence of our observer's order-increase algorithm. Two methodologies are demonstrated to solve the observer design equations. The second presented scheme, is a new design method that based on our observations has a better numerical performance than the first conventional one. Numerical examples and simulation results in the MATLAB/Simulink environment describe the overall observer design procedure, and highlight the efficacy of our new methodology to solve the observer equations in comparison to the conventional one.

Journal Updates:

September 2015

Automatica

Optimal move blocking strategies for model predictive control

Volume 61, November 2015, Pages 27–34

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Abstract

This paper presents a systematic methodology for designing move blocking strategies to reduce the complexity of a model predictive controller for linear systems, with explicit optimisation of the blocking structure using mixed-integer programming. Given a move-blocked predictive controller with a terminal invariant set constraint for stability, combined with an input parameterisation to preserve recursive feasibility, two different optimisation problems are formulated for blocking structure selection. The first problem calculates the maximum achievable reduction in the number of input decision variables and prediction horizon length, subject to the controller's region of attraction containing a specified subset of the state space. Then, for a given fixed horizon length and block count determined by hardware capabilities, the second problem seeks to maximise the volume of an inner approximation to the region of attraction. Numerical examples show that the resulting blocking structures are able to optimally reduce controller complexity and improve region of attraction volume.

Zeros of networked systems with time-invariant interconnections

Volume 61, November 2015, Pages 97–105

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Abstract

This paper studies zeros of networked linear systems with time-invariant interconnection topology. While the characterization of zeros is given for both heterogeneous and homogeneous networks, homogeneous networks are explored in greater detail. In the current paper, for homogeneous networks with time-invariant interconnection dynamics, it is illustrated how the zeros of each individual agent's system description and zeros definable from the interconnection dynamics contribute to generating zeros of the whole network. We also demonstrate how zeros of networked systems and those of their associated blocked versions are related.

Continuous-switch piecewise quadratic models of biological networks: Application to bacterial growth

Volume 61, November 2015, Pages 164–172

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Abstract

An extension of the class of piecewise linear (PL) systems is proposed to model gene expression dynamics dependent on dilution due to cell growth rate. The growth rate is modeled as the weighted minimum of two or more limiting gene products responsible for bacterial growth. The production terms are still piecewise constant, but now the degradation terms are piecewise quadratic (PQ). This new mathematical formalism exhibits continuous switches between PQ modes. We first study the novel dynamical behavior generated by the nonlinear terms at the regions of discontinuity of the vector fields, showing that the sliding motion configurations occurring in PL systems can further lead to damped convergent oscillations or periodic behavior in PQ systems. As an application, a core model of the bacterial gene expression machinery is studied with the goal of externally tuning the growth rate of cells. This system may exhibit several behaviors including bi-mode bistability or damped oscillatory behavior.

Graph-theoretic analysis of network input − output processes: Zero structure and its implications on remote feedback control

Volume 61, November 2015, Pages 73–79

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Abstract

The control of dynamical processes in networks is considered, in the case where measurement and actuation capabilities are sparse and possibly remote. Specifically, we study control of a canonical network dynamics, when only one network component's state can be measured and only one (in general different) component can be actuated. To do so, we characterize the finite- and infinite-zeros of the resulting SISO system in terms of the graph topology. Using these results, we establish graph-theoretic conditions under which there are zeros in the closed right-half plane. These conditions depend on the length, strength, and number of the paths from the component where the input is applied to the component where the measurements are made. Then, we present the implications of these conditions on the controller design task focusing in stabilizations/destabilization of network processes under static negative feedback.

Neural-networked adaptive tracking control for switched nonlinear pure-feedback systems under arbitrary switching

Volume 61, November 2015, Pages 119–125

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Abstract

This paper deals with the problem of adaptive tracking control for a class of switched uncertain nonlinear systems in pure-feedback form under arbitrary switching. Based on command filtered backstepping design and common Lyapunov function method, a robust adaptive neural-networked control scheme is proposed to guarantee that the resulting closed-loop system is asymptotically bounded with tracking error converging to a neighborhood of the origin. A universal formula for constructing common neural-networked stabilizing function and controller is designed. Differing from the existing results in the literature, the developed new design scheme only requires desired trajectory and common stabilizing functions/virtual control signals instead of them and their first derivatives at each step in backstepping design procedures, and does not need a priori knowledge of the signs of control gain functions. Simulation results illustrate the effectiveness of the proposed techniques.

System & Control Letters

The new issue is still in progress…

IEEE Transactions on Robotics

Path Planning for Single Unmanned Aerial Vehicle by Separately Evolving Waypoints

Volume: 31, Issue: 5, Page: 1130 - 1146

Yang, P. ; Tang, K. ; Lozano, J.A. ; Cao, X.

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Abstract

Evolutionary algorithm-based unmanned aerial vehicle (UAV) path planners have been extensively studied for their effectiveness and flexibility. However, they still suffer from a drawback that the high-quality waypoints in previous candidate paths can hardly be exploited for further evolution, since they regard all the waypoints of a path as an integrated individual. Due to this drawback, the previous planners usually fail when encountering lots of obstacles. In this paper, a new idea of separately evaluating and evolving waypoints is presented to solve this problem. Concretely, the original objective and constraint functions of UAVs path planning are decomposed into a set of new evaluation functions, with which waypoints on a path can be evaluated separately. The new evaluation functions allow waypoints on a path to be evolved separately and, thus, high-quality waypoints can be better exploited. On this basis, the waypoints are encoded in a rotated coordinate system with an external restriction and evolved with JADE, a state-of-the-art variant of the differential evolution algorithm. To test the capabilities of the new planner on planning obstacle-free paths, five scenarios with increasing numbers of obstacles are constructed. Three existing planners and four variants of the proposed planner are compared to assess the effectiveness and efficiency of the proposed planner. The results demonstrate the superiority of the proposed planner and the idea of separate evolution.

The Geometry of Confocal Curves for Passing Through a Door

Volume: 31, Issue: 5, Page: 1180 - 1193

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Abstract

This paper presents a geometric approach to the problem of steering a robot subject to nonholonomic constraints through a door by using only visual measurements coming from a single fixed on-board monocular camera. The door is represented by two landmarks located on its vertical supports. After exploring the geometric structure that naturally emerges from the problem statement, e.g., bundle of hyperbolae, ellipses, and circles, we exploit this planar geometry to provide stabilizing feedback control laws to drive the vehicle through the middle of the door. Using visual servoing, we prove that this geometry can be directly measured in the camera image plane. Hence, we provide an image-based control scheme, avoiding the use of a state observer. Simulations in a realistic scenario and experiments are provided to show the effectiveness of the feedback control laws.