Thesis subjects
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autumn 2014

Any topic can be adapted to either Bachelor (4-year degree) or Master level.

Titles are in English and Romanian, an English description is provided; the requirements are given in Romanian.

Grayed-out topics have already been assigned.

No.	Title / titlu	Description	Requirements / cerințe
1	Vision-based quadrotor control for railway following / Controlul bazat pe vedere artificiala pentru urmarirea liniilor de cale ferata de catre un quadrotor	In the robotics group, a new method has been developed over the past year for railway following. It uses vision-based detection of the vanishing point of the tracks and other objects in the image, and a PD controller to keep the vanishing point in the center of the image. This method works in simulation, while the vision part also works on real images. The goal of this project is to make the overall approach work on the real system. A new Parrot AR.2 quadrotor drone will be available for testing at the department. Contact: pall.elod@gmail.com, lucian@busoniu.net Daily advisor: Elod Pall (UTCN), also involved: dr. Laszlo Barabas (Accenture)	• Familiaritatea cu programarea in Matlab si C este necesara • Cunostinte bune de limba engleza, pentru a avea acces la literatura de specialitate • Experienta in robotica sau cu quadrotors este un plus Studentul va (i) studia literatura si implementarea furnizate (ii) implementa algoritmul de control (iii) evalua algoritmul pe sistemul real (iv) redacta lucrarea finala.
2	Vision-based quadrotor navigation around objects / Navigarea unui quadrotor in jurul obiectelor folosind vederea artificiala	Using image processing, the goal of this project ist o implement object recognition algorithms on a quadrotor in order to navigate around these objects, either for inspection purposes or for obstacle avoidance. For example, the objects could be power line posts. Methods have been implemented in our group for image processing in order to determine vehicle motion, and these have been tested on real movies. The final aim is to prove the methods work in real-time control of the drone. A new Parrot AR.2 quadrotor drone will be available for testing at the department. Contact: mathekoppany@yahoo.com, lucian@busoniu.net Daily advisor: Koppany Mathe (UTCN), also involved: dr. Laszlo Barabas (Accenture)	• Familiaritatea cu programarea in Matlab si C este necesara • Cunostinte bune de limba engleza, pentru a avea acces la literatura de specialitate • Experienta in robotica sau cu quadrotors este un plus Studentul va (i) studia literatura si implementarea furnizate (ii) evalua si selecta diverse solutii pentru detectarea obiectelor (iii) implementa solutia aleasa (iv) evalua algoritmul pe sistemul real (v) redacta lucrarea finala.

3	Vision-based lane following for an autonomous car / Urmarirea benzii de circulatie de catre un vehicul autonom folosind vederea artificiala	Autonomous cars are currently the focus of intensive research, with well-known projects such as the Google Driverless Car, and many other automotive companies and universities being involved in this line of research. An important problem that must be solved in this context is lane following. In this project, we will develop lane following control using vision-based detection to identify the lane markers. The approach developed will be directly applied to an autonomous Citroen C4 newly available at the Laboratory of Industrial and Human Automation control, Mechanical engineering and Computer Science (LAMIH) at Valenciennes. The project will take place at LAMIH within the Erasmus cooperation framework. The deadline for starting the Erasmus procedure is 1 November 2014. Advisors: Sebastien Delprat (LAMIH), Elod Pall (UTCN). Also involved: Lucian Busoniu (UTCN) Contact: lucian@busoniu.net	• Familiaritatea cu programarea in C/C++ si Matlab este necesara. • Cunostinte bune de limba engleza, pentru a avea acces la literatura de specialitate • Experienta in procesarea imaginilor si robotica este un plus Studentul va (i) studia literatura si implementarea furnizate (ii) evalua si selecta diversele solutii pentru detectarea liniilor de marcaj si a controlului bazat pe liniile detectate (iii) implementa solutia aleasa (iv) evalua algoritmul pe sistemul real (v) redacta lucrarea finala.
4	Optimistic planning for real-time crane control / Planificarea optimista pentru controlul in timp real al unei macarale	Optimistic planning is a recent approach to the predictive control of nonlinear systems, which optimistically explores the space of action sequences from the current state. No real-time control results exist yet for OP methods. This project will develop such results, for the problem of controlling a crane to move the load along a designated trajectory (experimental setup Inteco3D of lab C01). A preliminary simulation phase will be followed by real-time implementation and validation. Contact: lucian@busoniu.net	• Familiaritatea cu programarea in Matlab si C este absolut necesara • Cunostinte bune de limba engleza, pentru a avea acces la literatura de specialitate Studentul va (i) studia literatura si implementarea Matlab furnizate (iii) efectua teste preliminare cu un model de simulare (ii) reimplementa algoritmul in C pentru asigua constrangerile de timp real (iv) evalua algoritmul pe sistemul real (v) redacta lucrarea finala.
5	Optimistic planning for the rotational inverted pendulum / Planificarea optimista pentru controlul unui pendul inversat	Optimistic planning is a recent approach to the predictive control of nonlinear systems, which optimistically explores the space of action sequences from the current state. Few real-time control results exist yet for OP methods. This project will develop such results, for the problem of controlling a rotation inverted pendulum so that it swings up and then stabilizes pointing up (experimental setup of lab C01). A preliminary simulation phase will be followed by real-time implementation and validation. Contact: lucian@busoniu.net	• Familiaritatea cu programarea in Matlab si C este absolut necesara • Cunostinte bune de limba engleza, pentru a avea acces la literatura de specialitate Studentul va (i) studia literatura si implementarea Matlab furnizate (iii) efectua teste preliminare cu un model de simulare (ii) reimplementa algoritmul in C pentru asigua constrangerile de timp real (iv) evalua algoritmul pe sistemul real (v) redacta lucrarea finala.
6	Closing the tree in optimistic planning / Planificarea	Optimistic planning is a recent approach to the predictive control of nonlinear systems, which optimistically explores the space of action sequences from the current state. Existing OP algorithms represent the policies using a tree, ignoring repetitions of the same state. In this	• Familiaritatea cu programarea in Matlab este absolut necesara • Cunostinte bune de limba engleza, pentru a avea acces la literatura de specialitate

	optimista cu inchiderea arborelui	project, a method to „close the tree" will be devised, which takes repeated states into account, resulting in a graph with loops. Dynamic programming will be used to find a solution along the loops. The new method will be benchmarked and compared to the original one in simulation on several systems. Contact: lucian@busoniu.net	Studentul va (i) studia literatura furnizata (ii) dezvolta algoritmul integrat OP + programarea dinamică (iii) include modificarile in implementarea Matlab existenta (iv) identifica exemple potrivite şi evalua algoritmul pe aceste exemple (v) redacta lucrarea finala. Proiectul este parte a unei colaborari cu, si poate implica cercetatori de la INRIA Lille, Franta.
7	Finite-horizon optimistic planning / Planificarea optimista cu orizont finit	Optimistic planning is a recent approach to the predictive control of nonlinear systems, which optimistically explores the space of action sequences from the current state. OP algorithms natively focus on infinite-horizon control, but they can also be useful in finite-horizon settings. In this project, we will study the performance of OP in finite-horizon control, comparing it to some competing methods from the literature that natively find finite-horizon solutions. Several problems will be considered, such a DC motor or a resonating robot arm. Contact: lucian@busoniu.net	• Familiaritatea cu programarea in Matlab este absolut necesara • Cunostinte bune de limba engleza, pentru a avea acces la literatura de specialitate Studentul va (i) studia literatura de specialitate (ii) dezvolta extensia de orizont finit a algoritmului existent (iii) implementa modificarea in Matlab (iv) evalua algoritmul in exemple, comparandu-l cu metode competitive din literatura (v) redacta lucrarea finala. Proiectul poate implica colaborarea cu cercetatori de la INRIA Nancy, Franta.
8.	Planning applications to switched systems / Aplicatii ale planificarii la sisteme in comutatie	Optimistic planning is a recent approach to the near-optimal, predictive control of nonlinear systems. It works using discrete actions and so is naturally suited to the control of modes changes in switched systems, e.g. a power system where a generator can be turned on or off (corresponding to two modes). In this project we will identify interesting applications of planning in switched systems, looking among others at power systems, and compare planning in simulation with standard techniques to control these systems. Contact: lucian@busoniu.net	• Baze matematice solide • Cunostinte bune de limba engleza, pentru a avea acces la literatura de specialitate • Experienta cu Matlab Studentul va (i) studia literatura de specialitate si intelege tehnicile relevante (ii) cauta aplicatii la sisteme in comutatie in literatura (iii) testa algoritmul de planificare in simulare pe aceste exemple (iv) redacta lucrarea finala.
9.	Analysis of continuous-action planning / Analiza planificarii cu actiuni continue	Optimistic planning is a recent approach to the predictive control of nonlinear systems. These methods originally use discretized control actions, but recently, methods for continuous actions have been proposed, with good empirical results. In this project, we will theoretically analyze these methods. The goal is to interconnect the computation invested by the algorithm to the quality of the solution. A	• Spirit analitic si baze matematice solide • Cunostinte bune de limba engleza, pentru a avea acces la literatura de specialitate Studentul va (i) studia literatura de specialitate (ii) intelege tehnicile de analiza relevante (iii) integra

		restricted variant of the analysis already exists, but it must be adapted to the control problem. Contact: lucian@busoniu.net	aceste tehnici si analiza performanta OP cu actiuni continue (iv) redacta lucrarea finala.
10.	Optimistic planning with an adaptive number of switches / Planificarea optimista cu numar de comutari adaptiv	Optimistic planning is a recent approach to the near-optimal, predictive control of nonlinear systems. Recently we have developed an algorithm that optimizes the switching times between different control actions rather than allowing switches (changes) at every step. This algorithm is much faster but is limited by the quality of solution representable with a fixed number of switches. The goal of this project is to derive a criterion for adaptively increasing the number of switches allowed in the solution. This should allow the recovery of a near-optimal solution while still preserving a computational advantage with respect to the original algorithm that can switch at any time step.	• Spirit analitic si baze matematice solide • Experienta cu Matlab • Cunostinte bune de limba engleza, pentru a avea acces la literatura de specialitate Studentul va (i) studia literatura de specialitate (ii) intelege metodele relevante (iii) propune si testa empiric, in probleme de ex. din robotica, criterii de crestere a numarului de comutari (iv) optional, analiza algoritmul rezultat (v) redacta lucrarea finala.
11.	Optimal control with discrete actions using SOO / Control optimal cu actiuni discrete folosind SOO	Optimistic planning is a recent approach to the near-optimal, predictive control of nonlinear systems. It exploits a certain conservative smoothness property of the optimal value function to work. Here, we will use ideas from a different optimization algorithm called SOO in order to develop a planning method that better exploits the smoothness properties of the value function. Contact: lucian@busoniu.net	• Baze matematice solide • Cunostinte bune de limba engleza, pentru a avea acces la literatura de specialitate • Experienta cu Matlab Studentul va (i) studia literatura de specialitate (ii) intelege tehnicile relevante (iii) integra aceste tehnici pentru a dezvolta noul algoritm (iv) testa algoritmul in simulare pe exemple de control neliniar cum ar fi pendulul inversat si tratamentul HIV, (v) redacta lucrarea finala.
12.	Optimistic optimization for gossipping / Optimizarea optimista pentru probleme de gossipping	Gossipping is a technique for reaching agreement among the agents in a distributed system on some numerical quantity of interest (e.g., a robot team agrees on the location of a rendezvous). It works by selecting which communication channels are active at each time step. In this project, we will formulate this problem as combinatorial optimization, and investigate the application of so-called optimistic optimization techniques to solve it; extension of these methods may be required. We will compare the results with standard gossipping algorithms. Contact: lucian@busoniu.net	• Baze matematice solide • Cunostinte bune de limba engleza, pentru a avea acces la literatura de specialitate • Experienta cu Matlab Studentul va (i) studia literatura de specialitate si intelege tehnicile relevante (ii) formula problema de optimizare combinatorica pentru gossipping (iii) adapta algoritmii optimisti la aceasta problema (iv) testa algoritmul de planificare in simulare pe exemple standard din literatura (v) redacta lucrarea finala.