Gijón, 12 de diciembre de 2014

Se oferta la posibilidad de realizar el Proyecto Fin de Carrera / Trabajo Fin de Master en el

DLR - Deutsches Zentrum für Luft- und Raumfahrt.
(Agencia Aeroespacial Alemana) http://www.dlr.de/en/
Institute of Communications and Navigation
Weßling (Área Metropolitana de Múnich, Baviera)

Se ofrece:

- Realizar el PFC o TFM (Masters Thesis) en uno de los temas descritos en las siguientes páginas.
- Integración en un grupo de investigación internacional. El DLR está compuesto por 28 institutos de investigación e instalaciones en 8 sedes que en total suman a más de 5500 empleados.
- Fecha de incorporación flexible a negociar.
- La estancia está dotada con una ayuda bajo la figura de un contrato de estudiante (legislación alemana).

Requisitos de los candidatos:

- Buen expediente académico.
- Buen nivel de inglés. (No se requiere hablar alemán)
- Capacidad de trabajo en grupo.
- Ser alumno de **Ingeniería de Telecomunicación o Master Universitario en Ingeniería de Telecomunicación.** Alumnos de otros Masters también pueden ser candidatos, dependiendo del perfil.

Los interesados deberán aportar:

- Curriculum Vitae.
- Situación académica personal (certificado de notas y nota media de la carrera).
- Carta de presentación en la que se debe incluir:
  - el orden de preferencia de los temas ofertados.
  - cualquier aclaración como la disponibilidad de fechas para comenzar.

Toda la documentación se deberá presentar en formato electrónico y en inglés.

Fecha límite de recepción de solicitudes: **2 de febrero de 2015.**

Interesados dirigirse a: Manuel Arrebola Baena (arrebola@uniovi.es)

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Diploma / Master Thesis

Attribute-distributed learning for multi-agent robotic swarms

Your mission:

Distributed learning is a field that generalizes classical machine learning algorithms to a distributed framework in which data are distributed among a number of agents – multi-agent swarms. These agents are capable of exchanging certain types of information, which, due to limited computational power and communication constraints, is usually restricted in terms of content and amount. In terms of the way that data are disseminated among the swarm members, distributed learning can be categorized into homogeneous (instance distributed) and heterogeneous (attribute distributed) data. The latter case is more challenging since different agents observe different attributes (features) of the data and thus construct different forms of classifiers/estimators. This makes it harder to evaluate, compare and combine the estimators.

The goal of this Master Thesis is to investigate a cooperative, distributed, training strategy that utilizes two nonlinear parameter estimation algorithms – variational Bayesian Expectation-Maximization and variational Bayesian Space-Alternating Generalized Expectation-Maximization algorithms – in the context of attribute-distributed learning for multi-agent swarms. The former algorithm permits a consensus-like dissemination of information between agents that is more suited for close-range communication. The latter algorithm propagates information sequentially from one agent to the other and could be employed for communication between groups for agents.

The perspective candidate is expected to develop and test the corresponding learning algorithms in a synthetic environment. The special emphasis is placed on a distributed implementation the algorithms and analysis of the convergence rate for different swarm configurations.

Your qualifications:

- Excellent knowledge of signal processing and estimation theory
- Excellent command of MATLAB or Python
- Independent working and a good working knowledge of English or German

Your benefits:

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Diploma / Master Thesis

Multipath Assisted Positioning: Mapping of Virtual Transmitters

Your mission:

Positioning is one of the most important fields of applications for wireless radio transmissions. In critical environments, such as urban canyon or indoors, the position accuracy using wireless signals is drastically reduced. In these environments, multipath effects, low received signal power and non-line-of-sight propagation reduce the position accuracy. With Channel-SLAM, we proposed a paradigm shift in how to process the received signal in order to provide accurate position estimation for mobile receivers: rather than mitigating multipath, we propose to exploit multipath. Channel-SLAM treats multipath components as signals emitted from virtual transmitters which are time synchronized to the physical transmitter and static in their position. Hence, multipath propagation increases the number of transmitters by virtual transmitters resulting in more accurate position estimation or enabling positioning in situations where the number of physical transmitters is unsufficient. Channel-SLAM estimates the receiver position and the positions of the virtual transmitters simultaneously and does not require any prior information such as room-layout or a database for fingerprinting.

This Master thesis builds on and extends the previous work on Channel-SLAM. In order to exploit multipath components for multiple receivers, this Master thesis shall derive a mapping algorithm for virtual transmitters. The positions of virtual transmitters do not change over time, however, the virtual transmitters are only visible in a certain area. Hence, each virtual transmitter can be described by a static position and a visibility region. Thus, this Master thesis shall derive a representation of the visibility region of virtual transmitters and shall extend the current Channel-SLAM approach. Additionally, the results should be verified by simulations and/or measurements. The results might give valuable geometric information on the locations of reflectors and scatterers, which might enable to obtain geometric information of all kinds of environments by using wireless signals.

Your qualifications:

- Knowledge of ranging/positioning algorithms
- Excellent MATLAB knowledge
- Good mathematical/signal-processing background
- Independent working

Your benefits:

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Diploma / Master Thesis

Consensus Algorithms for Optimal Multi-Agent Path Planning in the Presence of Uncertainty

Your mission:

Autonomous robotic systems have received an increasing interest in the last years. In order to achieve autonomy, the robots must be able to decide by themselves how to transition from one initial state to a target state efficiently. Moreover we are interested in limiting the robot's probability of collision to a user-defined upper bound. The path planning problem becomes even more challenging when we consider several robots in the environment and we try to find the global optimal solution given some metric. Communication among the agents is necessary in order to reach a consensus to find their individual paths, while avoiding collisions with each other.

The goal of this Master Thesis is to investigate several distributed consensus algorithms to find an optimal global solution to the path planning problem. The global optimization problem will be constrained by the probability of collision with the environment and among the agents. The student will first investigate how to adapt some of the state of the art approaches to our specific problem; e.g. master-slave, token-based, etc. In a second step, complexity studies will be carried out to demonstrate the scalability of the system with the computational power of the agents and the planning horizon of the algorithm.

In addition to the development of the mathematical foundations and algorithms, this research will involve the validation of the work on real robotic hardware (swarm of UAVs).

Your qualifications:

- Independent working and fluent English
- Excellent knowledge of probabilistic methods
- Excellent command of MATLAB or Python
- Interest in theoretical analysis and experimental work

Your benefits:

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Diploma / Master Thesis

Two-way Ranging with LDACS1

Your mission:

Over the course of last several years, DLR has been actively working on developing a new L-band digital aeronautical communication system (LDACS) for civil aviation to meet the capacity requirements for future digital data link communications. LDACS1 is the broadband candidate and employs the Orthogonal Frequency-Division Multiplexing (OFDM) transmission scheme in both forward and reverse links. Recently, LDACS1 has been extended to include a ranging functionality. The LDACS1 signals from the ground stations are used to determine pseudo-ranges at the aircraft. Having available at least four range measurements from LDACS1 signals or other sensors allows for determining the aircraft position.

An alternative for ranging is to use LDACS1 signals transmitted by the aircraft. These aircraft requests are acknowledged by the ground station after a pre-determined time. With this, two-way ranging is possible with LDACS1 signals leading to range estimates instead of pseudo-ranges. The same functionality is currently performed by the so-called Distance Measuring Equipment (DME). Including "DME-ranging" into LDACS1 might finally enable to decommission DME and free L-band spectrum for further applications.

One main goal of this Master thesis is to determine the accuracy achievable with LDACS1 two-way ranging. To achieve this, a MATLAB simulation for two-way ranging including clock inaccuracies has to be set-up. The second goal of the Master thesis is to develop algorithms to improve the achievable range accuracy.

Your qualifications:

- Excellent knowledge of OFDM and good knowledge of ranging/positioning algorithms
- Excellent MATLAB knowledge
- Good mathematical/signal-processing background
- Independent working

Your benefits:

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Diploma / Master Thesis

FeetSLAM Automation with and without Wireless Measurements

Your mission:

Positioning in buildings and other environments where GNSS reception is difficult will require a combination of sensors and other information such as building plans in order to function accurately. We are pursuing sensor fusion approaches that combine GNSS, foot mounted inertial sensors, electronic compasses, baro-altimeters, maps and wireless distance measurements. A particularly powerful combination is INS step measurement in conjunction with maps, FootSLAM, which can converge to the correct position after less than a minute of motion. We have developed a two-layer sensor fusion architecture that operates with a Kalman filter where possible, and fuses other sensors and maps at a higher-level, lower rate, particle filter. FootSLAM's only features or landmarks are the probability distributions of human motion as a function of location.

FeetSLAM is simply cooperative FootSLAM. The objective is that data from many walks can be combined to generate a more accurate and more encompassing total FootSLAM map. We have implemented an iterative processing algorithm motivated by Turbo Decoding from channel coding theory that takes maps from one data set as prior maps for other data sets.

The main goal of this master thesis is to extend the current FeetSLAM framework to further enhance the fusion of the maps. Especially, available wireless measurements or prior information on the location and orientation of the maps shall be investigated. The implemented algorithms shall be tested through several experiments.

Further information on FootSLAM:

http://www3.dlr.de/kn/desktopdefault.aspx/tabid-8495/admin-1/14557_read-36757/

Your qualifications:

- Excellent knowledge of positioning algorithms (Kalman filter, particle filter)
- Excellent JAVA knowledge
- Good mathematical/signal-processing background
- Independent working

Your benefits:

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FootSLAM with Multiple Sensors

Your mission:

Positioning in buildings and other environments where GNSS reception is difficult will require a combination of sensors and other information such as building plans in order to function accurately. We are pursuing sensor fusion approaches that combine GNSS, foot mounted inertial sensors, electronic compasses, baro-altimeters, maps and wireless distance measurements. A particularly powerful combination is INS step measurement in conjunction with maps, FootSLAM, which can converge to the correct position after less than a minute of motion. We have developed a two-layer sensor fusion architecture that operates with a Kalman filter where possible, and fuses other sensors and maps at a higher-level, lower rate, particle filter. FootSLAM's only features or landmarks are the probability distributions of human motion as a function of location.

Whereas mass market ready pedestrian navigation can afford only a single IMU, professional market ready pedestrian navigation can afford several foot- and body-mounted IMUs. These should provide redundancy and a better performance in challenging environments.

Hence, the main goal of this master thesis is to extend the current FootSLAM framework to use several foot- and body-mounted IMUs. Both the theoretical and experimental performance shall be determined for walking and other motion modes. The extended system should be robust against sensor failures.

Further information on FootSLAM:

http://www3.dlr.de/kn/desktopdefault.aspx/tabid-8495/admin-1/14557_read-36757/

Your qualifications:

- Excellent knowledge of positioning algorithms (Kalman filter, particle filter)
- Excellent JAVA knowledge
- Good mathematical/signal-processing background
- Independent working

Your benefits:

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Diploma / Master Thesis

From FootSLAM to MotionSLAM – Non-Walking Motion Modes

Your mission:

Positioning in buildings and other environments where GNSS reception is difficult will require a combination of sensors and other information such as building plans in order to function accurately. We are pursuing sensor fusion approaches that combine GNSS, foot mounted inertial sensors, electronic compasses, baro-altimeters, maps and wireless distance measurements. A particularly powerful combination is INS step measurement in conjunction with maps, FootSLAM, which can converge to the correct position after less than a minute of motion. We have developed a two-layer sensor fusion architecture that operates with a Kalman filter where possible, and fuses other sensors and maps at a higher-level, lower rate, particle filter. FootSLAM's only features or landmarks are the probability distributions of human motion as a function of location.

In the Kalman filter, zero velocity updates (ZUPTs) are used to mitigate the drift effects of the IMU. Here, the fundamental assumption is that the pedestrian is walking on an even surface and the foot is always resting for a certain period of time during the walk. However, this assumption is not anymore valid for other motion modes such as walking on uneven surfaces, running, kicking stairs, climbing ladders, or crawling.

Hence, the main goal of this master thesis is to extend the current FootSLAM framework towards MotionSLAM enabling at least crawling. Two sensors shall be used, one foot-mounted and one mounted on the hip or on the thigh. The implemented algorithms will be tested with data measured in the holodeck.

Further information on FootSLAM:

http://www3.dlr.de/kn/desktopdefault.aspx/tabid-8495/admin-1/14557_read-36757/

Your qualifications:

- Excellent knowledge of positioning algorithms (Kalman filter, particle filter)
- Excellent JAVA knowledge
- Good mathematical/signal-processing background
- Independent working

Your benefits:

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Diploma / Master Thesis

An ultrasonic sensor array for environment sounding with sparsity constraints

Your mission:

If a robot wants to navigate through an unknown environment, it needs different sensors to interpret its surroundings. One way to sense the physical environment can be done with ultrasonic sensors. These sensors measure with the principle of Round-Trip-Delay. This principle is basically transmitting and receiving a signal, where the received signal is convoluted with the acoustic channel impulse response. In order to reduce the amount of measurements to estimate the physical environment, the channel's sparsity can be exploited. Whereas sparse means that the channel can be represented by few distinct signals. Outgoing from these distinct signals an optimization with sparsity constraints leads to the original signal, i.e. channel response.

The goal of this Master Thesis – on the one hand side - is to develop an ultrasonic sensor array for environment recognition, e.g. obstacle avoidance. Key parameters for development are the weight, the size and implementability with the given hardware on the quadrocopter. At this point the sensor array should work properly and is well defined and calibrated.
On the other side, the channel response's sparsity is exploited and optimization with sparsity constraints will be used to estimate the physical environment.

Your qualifications:

- Excellent C/C++ and good Python knowledge
- Very strong interest in circuit design and microcontrollers
- Very good mathematical/signal-processing background
- Independent working and high motivation to work with other scientists in a team

Your benefits:

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