

## A5.3 Mobile Systems – Path Planning

Time: Tuesday, 14.09.2010

Location: Humboldt-Building, Lecture Room 201

Chairman: Ch. Ament (DE-Ilmenau)

9:00 a.m.	Th. Kopfstedt, B. Steurer (DE-Überlingen)
<p><b>Development of an Algorithm for Convoy Tasks Fulfilled by UGVs in Partially Unpaved Terrain Using Modern Simulation Techniques</b></p> <p>This paper will present new highly complex simulation environments using the Microsoft Robotics Developer Studio with the simulation of cameras in combination with 3D Lasers and simulated self localization algorithms as testbed for autonomous behaviors. This simulation environment allows the increase of the development process and gives the chance to compare the capabilities of different algorithms under exactly the same conditions in large simulated environments considering the physical effects and the latencies of the simulated sensors including error models.</p> <p>We will present how this simulation environment is built using independent services and how this allowed us to adapt the simulation environment for different robotic systems running a Diehl BGT Defence. As an example we will present for one of our autonomous systems the development and transfer of an algorithm for object tracking and following for a convoy task from the simulation to the real system including experimental data.</p>	
9:20 a.m.	Th. Kopfstedt, B. Steurer (DE-Überlingen)
<p><b>Movement of an Autonomous System along Specified Waypoints with Consideration of the Terrain</b></p> <p>In urban environments with specified types of obstacles and a paved ground autonomous systems are already able to drive along specified waypoints and to fulfill tasks independent from a human operator. In open space with unpaved terrain, changing weather conditions and several changes of the illumination of the environment due to the movement of the sun, clouds etc. this task becomes quickly a challenging one which is not completely solved until now. Also the solution presented by us will not allow a successful movement on all kinds of terrain and in all weather conditions. But for some common weather conditions and a limited set of terrains the algorithms presented have a high chance in being successful to fulfill a waypoint navigation task.</p> <p>We will present the idea behind the concept, discuss some of the underlying algorithms in comparison with possible alternatives and show selected simulation results gathered with these algorithms.</p> <p>This includes the classification of the terrain into different types based on a fixed cell size and a specific A* derivate for the trajectory generation in real time that allows vehicle velocities up to 20 km/h.</p>	

9:40 p.m.	L. Xiao, J. Jouffroy (DK-Sønderborg)
<p><b>On Path Generation and Feedforward Control for a Class of Surface Sailing Vessels</b></p> <p>Sailing vehicles with wind as their main means of propulsion (i.e. our well-known sailboats, ships equipped with a kite or landyachts) possess a unique property that the paths they take depend on the wind direction, which, in the literature, has attracted less attention than normal vehicles propelled by propellers or thrusters have done. This paper considers the problem of motion planning and controllability for sailing vehicles representing the no-sailing zone effect in sailing. We present an extended algorithm for automatic path generation with a prescribed initial heading for a simple model of sailing vehicles going upwind, together with a feedforward controller guiding these vessels along desired trajectories of bounded curvature. Simulation results are hereby presented to illustrate the approach. Based on our previous work and inspired by the controllability analysis, we show mathematically that there always exists a wearing path linking the initial configuration to any other configurations in the space of the system for any established starting headings outside the no-go zone and for a final orientation to be decided upon. More specifically, a conventional way of path construction (i.e. by using of a sequence of straight line segments and arcs of a circle with fixed radius) is adopted here to build a feasible smooth trajectory, and we prove the existence of such paths. At the same time, a few construction results are presented as explanations.</p>	
10:00 p.m.	F. Müller, A. Gehr, A. Wenzel, A. Muth, B. Franz, Ch. Ament (DE-Ilmenau)
<p><b>Automatic Driving of an Outdoor Vehicular Platform using GPS and Photonic Mixer Device (PMD) Cameras</b></p> <p>Much research has been conducted in mobile robotics so far. The main difficulty lies in the correct perception of the environment. Various sensors are available for this task, e.g. camera, radar, lidar, sonar. Combination of these sensors in the sense of sensor fusion may lead to a more detailed picture of the environment. This paper presents a method for controlling a mobile platform on basis of the combination of information provided by GPS and information derived from vehicle sensory. The task defined for the vehicle is to automatically drive from a starting point to a goal position (both stated in WGS84 coordinate system) while circumnavigating obstacles. For this purpose, the control of the vehicle relies on the following inputs. First on the position information of a GPS sensor. Secondly on the sensor data of two photonic mixer device (PMD) cameras. Signal loss and multipath propagation of the GPS are problems and therefore have to be handled appropriately. The control of the vehicle is done by extracting road boundaries from the PMD data as additional control information. Furthermore the PMD cameras are for detecting obstacles. Test drives are used for evaluation of the control algorithm.</p>	
10:20 – 10:40 a.m. Coffee break	

10:40 a.m.	M. Eichhorn (CA-St. John's)
<p><b>Optimal Path Planning System in Time-Varying Environment</b></p> <p>This paper presents an algorithm for path planning in a time-varying environment based on graph methods. The methods presented make it possible to find an optimal path using defined requirements in a feasible time. The task of the introduced path planning algorithm using an AUV is to find a time-optimal path from a defined start position to a goal position with consideration of the time-varying ocean current. An additional consideration discussed in this paper is the determination of the optimal departure time. The solutions and algorithms presented in this paper are focused on path planning requirements for the AUV "SLOCUM" glider. These algorithms are equally applicable to other AUVs or aerial mobile autonomous systems. This paper is an abridgment of a research fellowship and has been previously published in parts in [1], [2], [3] and [4].</p>	
<b>12:00 noon – 1:30 p.m. Lunch Break</b>	