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Rozprawa Doktorska

Implementacja algorytmu autonomicznej jazdy
w symulowanym ruchu ulicznym

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Streszczenie rozprawy doktorskiej w języku angielskim

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The subject of the research is the possibility of using a fluid flow simulation to determine the path of vehicle movement in simulated traffic. Without a designated purpose of control, the task of the driven vehicle is to participate in the traffic in a consistent manner together with its participants. This leads to the idea of using fluid flow simulation to drive an autonomous vehicle efficiently and safely.

Chapter II reviews the literature on current solutions. Particular emphasis is placed on the most popular heuristic techniques for tracing the vehicle movement path: potential field, polynomial generation of trajectories and the field of movement vectors. The autonomous driving algorithm presented in this paper is a combination of all these techniques.

In order to check the effectiveness of the autonomous driving algorithms in safe conditions, it is necessary to find the best simulator for conducting sucj experiments. In Chapter III the criteria for the assessment of road traffic simulators and the assessment of the available solutions is presented.

Chapter IV examines fluid simulation and its usefulness in generating trajectories for autonomous driving. The LBM method shows the best properties for this use: its simplest two-dimensional configuration (D2Q4) is one of the fastest methods of generating fluid flow vectors, which additionally does not reproduce turbulence.

To confirm these discoveries, a simplified simulator was created in which the fluid flow with a moving vehicle was simulated with very low resolution. This technique showed a large influence of the ratio of the speed of the simulated liquid to the speed of the simulated vehicle on the shape of the

generated trajectories. It has been experimentally proven that while maintaining the determined ratio of these values, the generated trajectories are useful for a different range of road environments and systems.

Chapter V presents the final form of the autonomous driving algorithm based on fluid simulation. The algorithm has been carefully optimized to work on a graphics card equipped with many CUDA processors. Many of its data is not available to the main thread running on the CPU processor to avoid excessive copying of data between the RAM and graphics card memory.

The input to the algorithm is the view from the camera mounted on the front of the driven vehicle, segmented into categories depending on the passability. This view is then transformed using perspective inversion to simulate a bird's-eye view of a road situation. By superimposing a number of such views combined with the motion transformation and the bounding boxes of other road users, an occupancy grid is obtained on which the potential fields and the vector fields of the simulated fluid flow are generated. In the vector grid resulting from the combination of these fields, the directions of the vectors are traced using a tracing point. This point determines a temporary target to which the motion curve of the guided vehicle is mapped.

Chapter VI describes the tests of the algorithm using test scenarios available in the literature. Most of the test scenarios come from articles describing the heuristic techniques of autonomous driving. The performed tests confirm the effectiveness of the described algorithm, as the results are at the same or better level as the original algorithms using them. Thus, the thesis that the use of fluid simulations for effective driving of an autonomous vehicle is confirmed.