EVOLUTIONARY SENSORIAL DATA MINING FOR AUTONOMOUS NAVIGATION

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Abstract: This paper presents a method for optimizing reference tracks used as input by an autonomous vehicle. Given the track obtained by manual driving using a GPS sensor installed on the vehicle, an Evolutionary Strategy was used to improve the processing and tracking of autonomous driving. The algorithm solutions had results that were very similar to expert solutions.
Keywords: Sensorial Data Mining, Evolutionary computation, Autonomous Navigation.

INTRODUCTION

Although totally autonomous vehicles currently exist as an ideal there are partially autonomous systems that have obtained surprising results in specific environments. The available autonomous system used for this work was a car controlled by a fuzzy logic controller that was created as a result of the Autopia Project[1]. One of the greatest problems faced by this kind of system is related to navigation [8]. This is the problem confronted here, in particular the optimization of pathway tracking. Given an initial path, the objective is to obtain another path with fewer reference points in order to improve controller performance, track drawing and the time spent completing the entire circuit. The task of reducing the number of points in a path has been carried out manually by an expert until the development of this work. A kind of Evolutionary Computation(EC) algorithms [5], called Evolutionary Strategies(ES) [2], was proposed as the method for automatic optimization.There are other works that also make use of the EC to solve navigational issues, such as control [1], [3], path planning [9], path planning in cooperation [7] and/or obstacle avoidance and/or on-line and off-line real-time adaptation [10]. Since the optimization process presented here is a data mining process rather than typical path planning, consisting of reduction and noise removal for preexisting data, the process can be classified as an off-line process.

CAR SIMULATOR

A software simulator of the autonomous car was implemented. The simulator uses the same fuzzy logic controller as the real vehicle and it takes car cinematics into account to make the simulator as realistic as possible. The output values that result from the simulation were used to calculate the fitness function needed for the ES algorithm.

ES DESIGN

EAs (Evolutionary Algorithms) use a technique that simulates the evolution theory of species [4], [6]. Beginning with an initial population, individuals evolve from generation to generation, by selective recombination between them and by mutation, so that superior individuals are generated during the evolution process and the overall population fitness is improved at the end. If the individuals are considered to be tentative solutions to a problem the evolutionary process can be viewed as a process of optimization, where the goodness of the different solutions is the optimization target and the output is the best individual of the final generation.
In this case, the objective is to optimize the track that is obtained automatically from a GPS sensor during a manual driving session, composed of too many points. This makes autonomous driving very slow and noisy, thus creating lateral offset errors in tracking. So, the tentative solutions are track maps, that can vary in size, represented as two-dimensional point sequences together with two reference speed values. The fitness of the track maps is a complex function depending on size, lateral offset error and the time spent in computer-controlled driving.

CONCLUSIONS

After an experimental fine tuning of the algorithm parameters, which revealed the advantages and disadvantages of the different proposed configurations and parameters, the solutions that were obtained were very similar to expert ones in terms of performance, as seen in Fig. 1, which makes them suitable for actual usage.

[1] http://www.iai.csic.es/autopia/

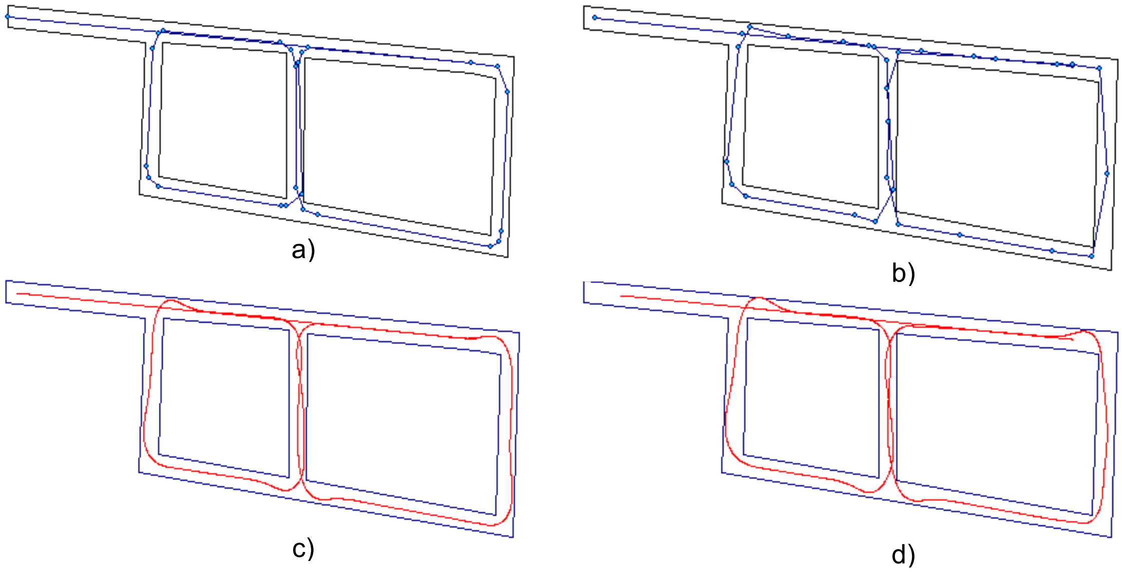

Fig.1. (a) Manually optimized solution. (b) The best solution that resulted from ten executions of the ES algorithm. (c) Simulation drawing of (a). (d)Simulation drawing of (b).

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