Autonomous Vehicle Parking using Finite State Automata Learned by J-CC Artificial Neural Nets

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Abstract

This paper presents the SEVA system (Autonomous Vehicle Parking Simulator). This tool implements a robust control system for autonomous vehicle parking based on a FSA (Finite-State Automata) and also based on FSA obtained from trained J-CC ANNs (Jordan Cascade-Correlation Artificial Neural Networks).

1. Introduction

This work intends to implement an intelligent control system for autonomous vehicle parking, based on previous work developed in the Praxitèle European Project [2,4]. Our main goal was to use sensorial information (proximity sensors) in order to control and safely park a vehicle into a parallel car space.

We started our research project implementing a car simulator [3] including proximity sensors model (infrared sensors), kinematics model (as adopted in [4]), and simulated actuators used to control speed and steering wheel. The initial version of this simulator – SEVA-A (Automata based Vehicle Simulator) was based on Finite-State Automata (FSA) used to control the vehicle. The implemented FSA was hard coded using a set of user specified rules to determine state transitions between car states (e.g. searching for space, positioning, aligning).

In order to improve our system robustness, we started to study how to introduce practical experience (learn from experience) in the system, and thus providing some learning ability to the control system. This learning ability of our system was provided through the use of Cascade-Correlation based Artificial Neural Networks [1]. We developed the SEVA-N (Neural based Vehicle Simulator) substituting FSA based controller by an ANN controller.

2. Method and Implementation

Initially a Finite-State Automaton (FSA) was developed in order to control the vehicle performing a parallel parking manoeuvre. However this controller was sensible to initial conditions and sensors/actuators imprecision.

Therefore, we decided to reproduce the FSA using an ANN, training this net in order to get a more robust controller. A special model of ANN, called J-CC (Jordan-Cascade Correlation), was designed to learn how to control the vehicle during the parking manoeuvre. The Neural Controller (SEVA-N) uses as inputs the sensorial information (sensors) and the present automata state, and obtains as outputs the speed control (car velocity), the wheels angle (car orientation), and also the next automata state. From a given present state the ANN can generates the next state (keep the present state, or change to a new state) and then re-inject this state in the ANN input; operating like Jordan Recurrent Nets. The ANN learning was provided by a fast and incremental MLP learning algorithm – Cascade Correlation Algorithm [1].

3. Results and Conclusions

Our simulation experiments have shown that our system can safely park the vehicle, using both methods: FSA or J-CC trained nets. We concluded that the proposed ANN model is suitable to be applied with success in this control problem and also can be applied in more complex tasks.

4. References

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