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Neural Network based Guide Robot Navigation: An Evolutionary Approach

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Abstract

Abstract— Intelligent robot navigation in urban environments is still a challenge. In this paper we test if it is possible to train neural networks to control the robot to reach the target location in urban dynamic environments. The robot has to rely on GPS and compass sensor to navigate from the starting point to the goal location in an environment with moving obstacles. We compare the performance of three neural architectures in different environments settings. The results show that neural controller with separated hidden neurons has a fast response to sensory input. The performance of evolved neural controllers is also tested in real robot navigation. In addition to the neural network based navigation, the robot has also to switch between other navigation algorithms to reach the target location in the university campus.

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1. INTRODUCTION

There are many challenges for robot navigating in urban environments because these environments are highly unstructured and have different characteristics. Therefore, the robot has to rely on different sensors and switch between different navigation algorithms for a safe reach of the target location. Lidoris et al. [6] presents a robot

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navigation method in unknown urban environments relying only on the information extracted through the interaction with passers-by and its local perception capabilities. Thrapp et al. [7] presents a robust localization for the robot in outdoor environments using GPS and extended Kalman filter. The localization error was reduced up to 0.4m. In our previous work, we presented several navigation algorithms for the guide robot ([8]). The robot utilizes the Laser Range Finder (LRF), Camera, GPS and compass sensors to navigate in environments with different characteristics and reach the target location. The robot was able to select the appropriate navigation algorithm based on the environment conditions. In addition, we evolved neural networks for robot navigation in open squares environments. The neural controllers were evolved in simple environments without fixed or moving obstacles.

Vision based robot navigation in urban environments has been widely used. Several approaches use the teach and replay paradigm ([9], [10]). In the teaching stage, the robot moves manually through a desired route, and then in the replay stage the robot moves autonomously replicating the teaching route. However, if the robot deviates from the target route due to an unpredicted obstacle, it is difficult to get the robot back on the target route. Pedestrian lane navigation using visual sensor has been also widely investigated with very promising results. The vanishing point method recognizes the road in the image. Most of the approaches use consensus direction or local textures or image edges to determine the most probable vanishing point ([11], [12], [13]). Siagian et al [14] presented a vanishing point detection algorithm that uses long and robust contour segments. Most of visual robot navigation in urban environments focus on pedestrian lane detection and following. However, in open square environments, the robot cannot rely on the visual information to follow a specific route to the target location. The robot has to rely on other sensors in order to estimate the heading and the moving direction.

In this paper, we compare the performance of different neural controllers for robot navigation in dynamic environments. The robot has to rely only on LRF, GPS, compass and camera sensors. The controllers are neural networks with different structures. The neural controllers are evolved in static and dynamic environments with moving and stationary obstacles. The robot controlled by the evolved neural networks show different behaviors. The best evolved neural controllers in simulated environments are also tested in the real hardware of the Guide Robot showing a good performance. In addition, we improve the navigation algorithm in narrow pedestrians. The robot adjusts its speed based on the walking speed of the user.

The paper is organized as follows. In Section II, the task and environment are presented. The neural architectures and the evolutionary algorithm are discussed in Section III. Simulation and experimental results are presented in Section IV before concluding in Section V.

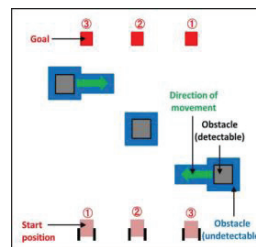


Figure 1. Neural Architectures.

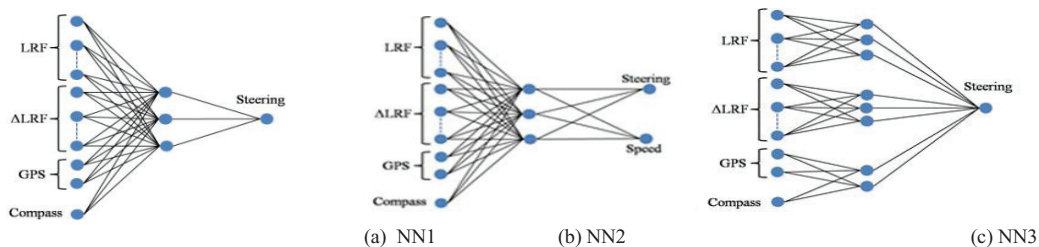


Figure 2. Neural Architectures

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