Comparing Finite State MacHines and Artificial Neural Networks for Controlling a UGV

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ABSTRACT

Unmanned ground vehicles (UGVs) are well suited to tasks that are either too dangerous or too tedious for people. For example, UGVs can be used to locate disaster victims. However, it is difficult to design these system so that they perform well in a variety of different environments. In this study, we have evolved controllers and physical characteristics (dimensions of the chassis and wheel) of a UGV to improve its mobility in a simulated environment. The UGV's mission is to visit a sequence of coordinates in order while automatically handling obstacles of varying sizes. Results from evolving a hand-designed finite state machine (FSM) and artificial neural networks (ANNs) were compared, and a new FSM was designed base on principles learned from the best ANN controller. Results show comparable performance between FSM and ANN controllers, and in the optimal physical characteristics of the UGV. The FSM designed by analyzing the ANN provides the advantages of both approaches: (1) the control system is no longer a black-box and can be predictably understood, and (2) it takes advantage of the continuous nature of an ANN. UGVs are valuable in many domains, however, they must be designed to work in many different environments. Our results show that a UGV's controller and physical characteristics can be effectively optimized using an evolutionary algorithm.

CCS CONCEPTS

- **Computer systems organization** → **Evolutionary robotics**;
- **Computing methodologies** → *Evolutionary robotics*;

KEYWORDS

robotics, artificial neural network, finite state machine, adaptive

1 INTRODUCTION

Autonomous unmanned ground vehicles (UGV) provide an excellent solution to any task that requires searching or monitoring in environments that are too inconvenient or dangerous for humans. Consider the *search and rescue* task: after a natural disaster a UGV can be used by first responders to help locate victims in unstable and hazardous locations. Compared with an unmanned aerial vehicle (UAV), a UGV has a longer operating duration and can carry heavier sensors. Ideally, a heterogeneous swarm of UAVs and UGV would coordinate on this task to gain the advantages of both search modes [1]. In this paper, however, we are only concerned with UGVs.

One issue that arises during the design of a UGV is how to ensure that the system can handle many different types of terrain. Researches have invented several different methods for addressing the issue of mobility in varied terrain. Specifically, robots have been designed with treaded wheels, tracks, legged-wheels (wheels are rimless, wheel spokes make contact with the ground), wheeled-legs (wheels are on the end of legs and the suspension is potentially actively actuated), or transformable wheels. The device in this study, called the *Adabot* (see Figure 1), includes transformable wheels that can smoothly be converted from a round wheel to a wheel, to a wheel with tire *studs*, to a legged-wheel.

Figure 1: This is a temp caption.

REFERENCES

[1] Kazuya Yoshida and Satoshi Tadokoro, (Eds.) 2014. *Experience in system design for human-robot teaming in urban search and rescue. Proceedings of 8th International Conference on Field and Service Robotics*. Springer Berlin Heidelberg, Berlin, Heidelberg, 111–125. ISBN: 978-3-642-40686-7. DOI: 10.1007/978-3-642-40686-7_8. https://doi.org/10.1007/978-3-642-40686-7_8.

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