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Autonomic Vehicles

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Abstract

If you thought intelligent cars capable of negotiating a city centre with no driver behind the wheel was just a fantasy of Hollywood – think again. Throughout the history of robotics, robots have been designed to fulfil a multitude of tasks, from opening doors to flying space shuttles to the moon. In this paper, we explain the evolution of robotics in the field of cars and how robotics can be used to make the humans redundant in controlling a car.

Keywords: Autonomic vehicles, Autonomous systems, Robotics

1. The evolution of robotics through cars

Perhaps the touchstone or founder of the idea of a robot driving a car would have to be the immense success of the computer that is capable of playing sports games such as chess as this opened up the field of progressing artificial intelligence to perform a wide range of tasks (Taney et al., 2005). There are still several leaps of technology to be implemented into robotic autonomous cars before we are capable of creating cars which can navigate through race tracks by themselves akin to the times of professional competitors.

The DARPA Grand Challenge is the de facto annual competition for autonomous vehicles where autonomous cars are required to navigate through a gruelling desert track in the Mojave Desert, Nevada. The first challenge was in 2004 but no car completed the course. In 2006, an autonomous car completed along with several other cars which finished in the allotted time given. This is a great feat in the development of technology for autonomous vehicles on the road but it was not done overnight. There has been years of research into developing these systems. A difficult part is to create an obstacle avoidance system which is capable of detecting not only the immobile but also the mobile objects that will be approaching it. (Graefe & Jacobs, 1991) for instance discuss how this might be achieved by encoding 7 subtasks into the systems recognition system. These are as follows:

(1) Detecting faster vehicles at a distance when they are approaching from behind.

(2) Tracking the detected vehicle while they continue to approach from behind.

(3) Detecting a passing vehicle a second time when it first enters the field of view of a forward-looking camera.

(4) Tracking the vehicle in the image after it has passed the robot, until it is so far ahead that its backside is completely visible.

(5) Changing to a different tracking mode and further tracking the vehicle in the image until its distance exceeds a certain safety limit.

(6) Instantiating and updating a spatio-temporal model of the passing vehicle while it is being tracked to determine its relative speed and distance.

(7) Coarse classification of the passing vehicle (truck, car, motor cycle) while it is being tracked (Graefe & Jacobs, 1991).

The arrows representing the sensors of the robot detecting the car on its approach towards it and past it along with the surrounding objects are depicted in Figure 1.

One of the necessities in robotic vehicles is the development of evolvable intelligence that can de designed and implemented into the functionality of the vehicles. An example is the recent project taken on by the University of Essex led by Dr Simon Lucas of the Department of Computer Science who intend to take the evolution of the artificial intelligence of automated vehicles to the next stage. The proposed system employs an artificial intelligence that will allow the robotic car to essentially think for itself and be able to adapt automatically to changes in surroundings without needing a new subroutine uploaded (Note 1).

Throughout the development of autonomous vehicles there have been several developments in the principles used to create a fully functional artificial intelligence. Some of these principals include invariant features, invariant matching,

localisation and map building (Pradalier and Sekhavat, 2002). These principals are necessary to create a working artificial intelligence which is able to travel from one location to the other by itself which are the stepping stones in an ever evolving artificial intelligence race to develop the first completely autonomous vehicle for common use. When creating an autonomous vehicle there are two essentials, hardware and software. While the software needed to operate the machinery is going to play an integral part of the functionality of the vehicle if it does not have the appropriate equipment to operate then it will not function.

An excellent example of the evolution of the artificial intelligence used in cars is that of Julian Togelius who has created an autonomous vehicle who can drive aggressively through a race track without being programmed how to drive. No human has told the cars how to drive, or indeed how to manoeuvre aggressively so that competitors crash into walls. Instead, evolution strategies (similar to genetic algorithms) were used to evolve neural networks that control the cars (Togelius, 2006). The creation of this technology was developed by firstly using random networks to see which ones operate properly. When these networks are found they are then recreated with minor changes such as in the evolution of a sentient being. The experimental vehicle started of only being able to drive on a standard track using collision detection software. An image of the sort of track used is shown in Figure 4.

As can be seen, the track is extremely simple in design so that the vehicle can be tested to see if the networks being used are functioning within the set parameters. After a training period, the vehicle is allowed to learn other more complicated tracks without any intervention by allowing the artificial intelligence control of the positioning of the sensors so that is more accurate. Problems still exist when two vehicles are racing on a track in that whenever a car is rewarded for being in front of another while racing, the cars behaviour becomes quite aggressive and attempts to force the other off the track (Togelius and Lucas, 2005).

2. Conclusion

There have been immeasurable advancements in the field of robotics in the past from the simple artificial intelligence that could play chess to the advanced ones that can navigate a car through a race and adapt to different situations without the intervention of a user. There may indeed be numerous autonomous vehicles sooner than we think.

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Notes

Note 1. http://www.essex.ac.uk/news/2007/nr20070320.htm

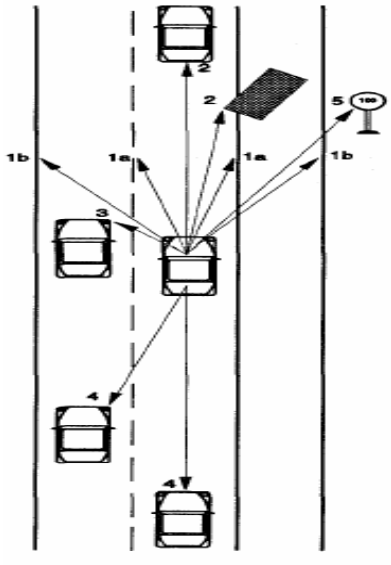

Figure 1. Robotic Sensors (Graefe, 1992)

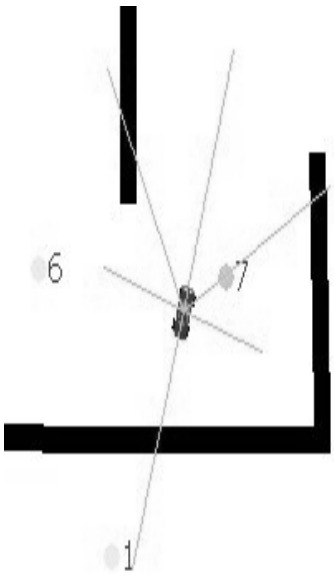

Figure 2. Track (Togelius, 2006)