Coursework 1: Wall Following with a LEGO Robot

Thomas AE. Smith

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1 Introduction

Built a mindstorms robot, implemented basic subsumption article as discussed in Brooks (1991) and discussed in more detail in Brooks (1986).

2 Approach

A small range of values for R were tested for the circumnavigation of a typical kitchen. The robot was placed in the same position and orientation for each of five repetitions of each of three values of R — 60cm, 80cm and 100cm. The timer started at the same time as the robot, and was stopped once the robot had circumnavigated the area and detected an obstacle beyond its starting point. Each condition was repeated until five successful datapoints were collected - causes for unsuccseeful attempts are descripbed in Appendix 7. Sources of variation in running times within values of R include the unreliablilty of the ultrasonic sensor when approaching objects at low angles of incidence or teatowels, non-deterministic outcomes if a collision occurs while the robot is moving backwards, and potential non-deterministic outcomes from bumper collisions due to wheel slippage or friction. In order to help discount the decrease in battery charge over the course of the experiment as a potential bias factor, the first experimental condition was repeated once after the other experiments had been performed, and the time obtained was within one standard deviation of the original mean.

I worked alone on this project, using one of the commercial NXT kits rather than the educational kit - supplemented with a set of wheels from my own supply that matched the ones provided with the educational kit.

2.1 Morphology

2.2 Behaviour

Brooks (1991)

2.3 Experiment

3 Results

4 Discussion

5 Conclusion

References

Brooks, R. A. (1986). A robust layered control system for a mobile robot. *Robotics and Automation, IEEE Journal of*, 2(1):14–23.

Brooks, R. A. (1991). Intelligence without representation. *Artificial Intelligence*, 47(1–3):139–159.

6 Raw Data

7 Unsuccessful attempts

Experimental attempts fell into four categories:

Successful: The robot successfully circumnavigated the area and detected a feature beyond its original starting point. A datapoint was recorded with the number of seconds it took to do so.

Crash: The provided ultrasonic sensor API functions are not thread safe. Due to the use of both motor and sensor listeners, occasionally one detection is still being processed when another arrives, resulting in a ConcurrentModificationException.

Fail: Two main failure modes were observed during the course of experimentation. The robot has a small blind spot directly ahead of it, that the side bumpers do not cover. If an object sufficiently thin or angled to evade ultrasonic detection (such as a metal chair leg or corner of a unit) enters this blind spot, the robot may become stuck against it. Alternatively, due to the triangular wheelbase it is possible in some circumstances for the robot to tip up and become stuck on two wheels or collapse.

Stall: As the robot has no rearward-facing sensors, it is possible for it to collide with an object while moving backwards to avoid another collision. In most cases this is not a significant problem, though it can non-determinisitcally change the robot's orientation. In some cases it is possible for the power of the motors to drive the rear wheel up the object sufficiently for the ultrasonic sensor to detect the floor as a false positive, and attempt to back away from it. This leads to a stall in the motors.