Robotics Report

Group Coursework

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Part A

Reactive Braitenberg behaviours

Design

In this part of the coursework, we have attempted to recreate four Braitenberg behaviours: aggression, fear, love and curiosity. Such behaviours can be achieved by controlling the speed of the robot (i.e E-Puck) based on the sensor detection values. In fact, as explained by Braitenberg (1984), it is possible to simulate 'simple' behaviours by increasing/decreasing the speed of the motors for high value sensors. By taking into account a vehicle with two front sensors, one on each side, and two motors, right and left (Figure 1) it is possible to have two kind of vehicles, depending on whether the sensor to the motor is connected on the same side (a) or on the opposite side (b). Using such design, it is possible to make the vehicle respond in different ways in the presence of a stimulus. In fact, as Braitenberg (1984) illustrates, by having a positive influence sign, the vehicle will tend to accelerate when the sensors are excited. If the source is directly ahead, it may hit the object. However, if the source is on one side, one sensor is excited more than the other, resulting in different behaviours (observable in Figure 2). Vehicle (a) would accelerate the wheel parallel to the activated sensor, eventually running away from the detected object. This behaviour is named *Fear*. On the contrary, if the object is on one side of vehicle (b), this will turn toward the object and ultimately hit it. Such behaviour is called *Aggression*.

By switching influence sign from positive to negative, the vehicles respond differently to a stimulus, resulting in a new set of behaviours. By having a negative influence sign, the motor attached to the activated sensor will slow down in the presence of a stimulus. As it can be observed in Figure 3, when approaching the source, vehicle (a) will decrease the speed of the parallel sensor, eventually stopping close to it. Such behaviour is called *Love.* On the other hand, by having the sensor-

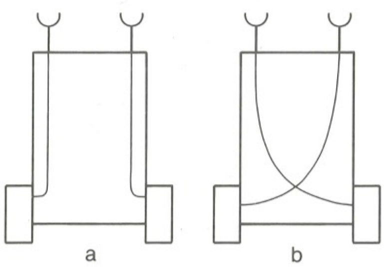


Figure 1: *Vehicle 2* (Braitenberg, 1984, p.7) with two motors and two sensors.

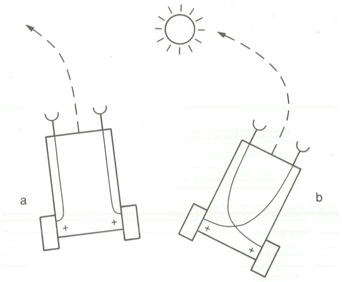


Figure 2: *Vehicle 2a and 2b* (Braitenberg, 1984, p.8) simulating Fear and Aggression.

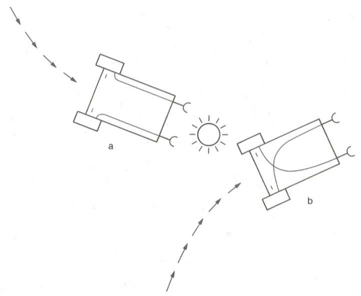


Figure 3: *Vehicle 3a and 3b* (Braitenberg, 1984, p.11)
simulating Love and Curiosity.

motor control crossed, the vehicle decreases its speed in the presence of the source while turning away. This will result in an increase of the speed as the vehicle gets away from the source (Braitenberg, 1984). This is referred to as *Explorer* (or *Curiosity*).

All the four behaviours have been successfully implemented in the E-Puck robot. In order to make the robot exhibit the behaviours, we used four different selectors:

- selector 0: fear;
- selector 1: curiosity;
- selector 2: aggression;
- selector 3: love.

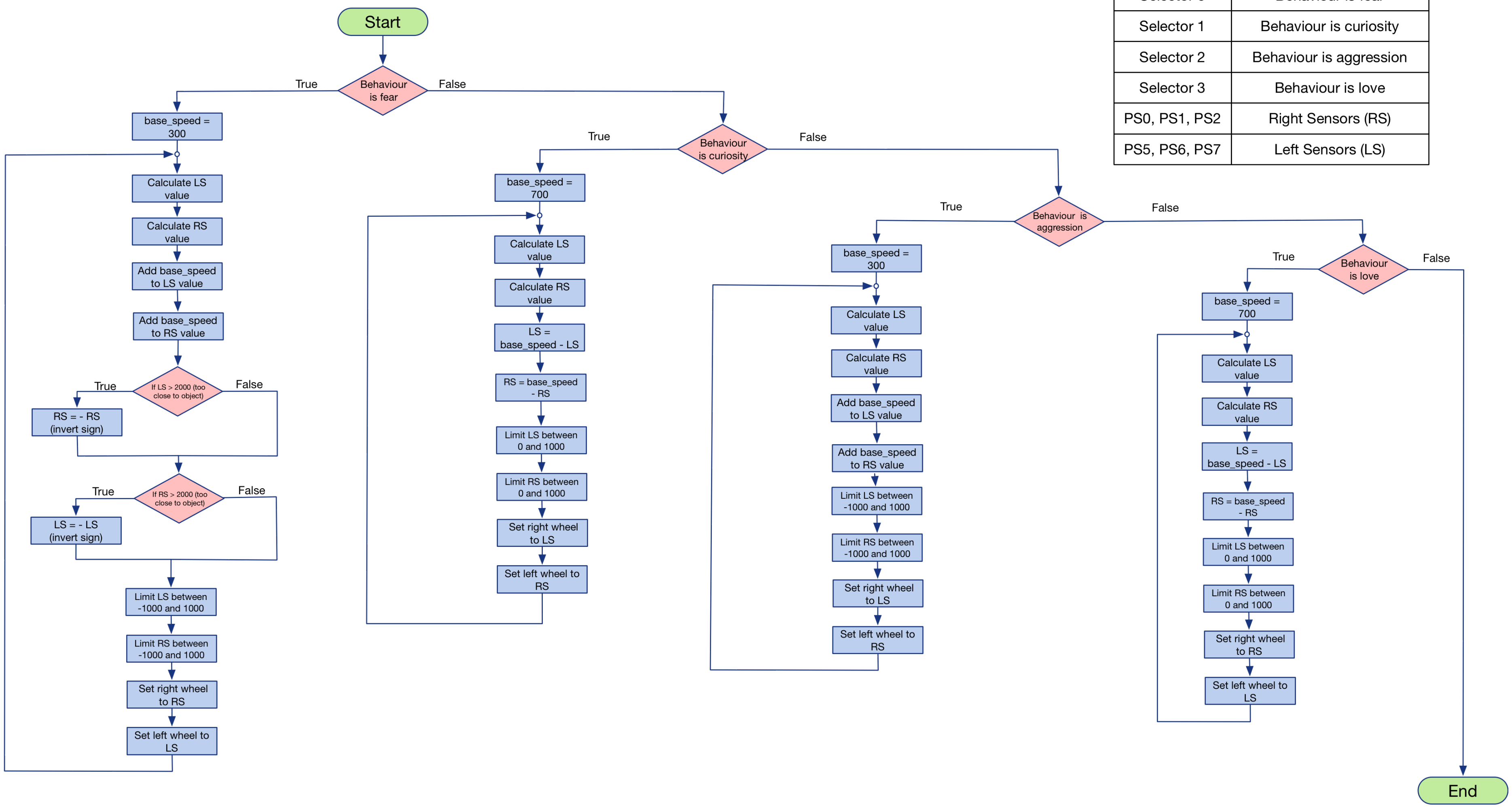
Consequently, the robot is only capable of representing one behaviour at the time. This results in the robot equally treating every detected object according to the selected behaviour.

Based upon Braitenberg's approach, we classified E-Puck's proximity sensors into two categories: "right sensors" and "left sensors". Under this scheme, we considered the top-right proximity sensors of the E-Puck (PS0, PS1, PS2) to be "right sensors" and the top-left ones (PS5, PS6, PS7) to be "left sensors". The reason for neglecting to use the rear sensors (PS3, PS4) is to prevent the robot from behaving eccentrically while moving away from the source (for instance, being attracted back to the object). Logically, this could be explained by thinking that the robot could only sense what is in front of it.

The left and right sensors are used to constantly monitor the adjacency of the robot's surroundings, returning high values when in proximity of an object. To such values is then added a basic speed, which is set differently for each behaviour. The result is then used to adjust the corresponding wheel's speed, according to the behaviour. In the case of *Fear*, these values are further used to examine whether the robot is excessively close to an object. In such cases, then the sign of the values are inverted, allowing the robot to move backwards slightly, exhibiting the behaviour correctly. A more detailed insight of the process can be observed in the flowchart overleaf.

Flowchart and function description

E-Puck Hardware	Flowchart terminology
Selector 0	Behaviour is fear
Selector 1	Behaviour is curiosity
Selector 2	Behaviour is aggression
Selector 3	Behaviour is love
PS0, PS1, PS2	Right Sensors (RS)
PS5, PS6, PS7	Left Sensors (LS)



Description of the main program functions for Part A:

fear()

This function contains the *Fear* behaviour. The basic speed, the speed of the wheels when there is no sensory input, is set to 300. As a result, when the robot meets an object, the increase on the speed is more noticeable. The maximum speed of the wheel is set to 1000, while the minimum is set to -1000 (this represent the fastest speed the wheels can go in reverse). After having detected the proximity values for each sensor set (left and right), each side's sensor value is set to be the sensor value itself added to the basic speed. The right wheel speed is then set to the newly calculated right sensor value; similarly, the newly calculated left sensor value is assigned to the left wheel. However, if any of these two values are over a limit of 2000 (meaning that the object is extremely close to the robot) the sign of the value is inverted. This allows the robot to move backwards slightly, exhibiting the behaviour correctly. Hence, as the sensory value for a sensor on one side increases, the motor for the same side of the robot will increase in speed.

curiosity()

This function contains the *Curiosity* behaviour. The basic speed is set to 700, in order to make the robot relatively fast when it is not detecting any objects. By doing so, the reduction of the speed is more noticeable when the robot approaches an object. The maximum speed of the wheel is set to 1000, while the minimum is set to 0 (this represent the fastest speed the wheels can go in reverse). After having detected the proximity values for each sensor set (left and right), each side's sensor value is set to be the sensor value itself subtracted by the basic speed. The right wheel speed is then set to the newly calculated left sensor value; similarly, the newly calculated right sensor value is assigned to the left wheel. Hence, as the sensory values increase at the front, the robot will slow down. This will make the robot repel the object once close enough, speeding up as it moves away.

aggression()

This function contains the *Aggression* behaviour. As per the fear() function, the basic speed is set to 300, while the maximum and minimum speed of the wheel is set to 1000 and -1000 respectively. After having detected the proximity values for each sensor set (left and right), each side's sensor value is set to be the sensor value itself added to the basic speed. The right wheel speed is then set to the newly calculated left sensor value; similarly, the newly calculated right sensor value is assigned to the left wheel. As a result, as the sensory value for a sensor on one side increases, the motor for the opposite side of the robot will increase in speed.

love()

This function contains the *Love* behaviour. As per the curiosity() function, the basic speed is set to 700, while the maximum and minimum speed of the wheel is set to 1000 and 0 respectively. After having detected the proximity values for each sensor set (left and right), each side's sensor value is set to be the sensor value itself subtracted by the basic speed. The right wheel speed is then set to the newly calculated right sensor value; similarly, the newly calculated left sensor value is assigned to the left wheel. Therefore, as the sensory values increase, the robot is 'attracted' to the object, causing the increase. The robot also slows down as it gets closer. After getting close enough, the robot will stop and perform a signal of 'love' (lighting up the body lights).

Test procedure and result analysis

In order to test the correctness of each behaviour, no special environment's set up was required. It has been sufficient to place the robot on a straight surface (e.g. a table) long enough for the robot to safely navigate on it. A handful of objects were then positioned on the robot's path in order to observe the response of the vehicle to the object.

The results have fulfil expectations. Each behaviour is exhibited correctly from the robot, as per behaviour explanation in section Design.

Conclusion

The experiment in this Task simulated four Braitenberg's behaviour (fear, curiosity, aggression, love) on an E-Puck robot. By adjusting the wheels speed according to the sensor values and by changing the influence sign from positive to negative, we have been able to create the set of behaviours required. Upon the correct choice of the selector, the E-Puck is now capable of reacting differently when approaching obstacles.

Part B

Goal seeking and obstacle avoidance

Design

Design explanation.

Flowchart and function description

http://www.breezetree.com/article-excel-flowchart-shapes.htm
The flowchart of the system + Description of the classes or program functions

Test procedure and result analysis

The program test procedure, results and analysis

Conclusion

Conclusion for this part.

Part C

High level behaviour

Design

Design explanation.

Flowchart and function description

The flowchart of the system + Description of the classes or program functions

Test procedure and result analysis

The program test procedure, results and analysis

Conclusion

Conclusion for this part.

Bibliography

Braitenberg, V. (1984) V*ehicles: Experiments in Synthetic Psychology*. Massachusetts: The MIT Press.