E-Puck Behaviour Implementation

Robotics and Intelligent Systems

COP518

Authors:
Ross McQuillan
Amr Yousef
Xinyu Chen

Supervisor:
Dr. Qinggang Meng

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Contents

1 Introduction

Within the Robotics and Intelligence systems module groups worked together to implement different behaviours with an E-Puck. Many different behaviours were available for implementation, including attraction, hate and aggression.

This report will explain, in detail, the tasks set out before each group. It will progress by explaining the design established to tackle these objectives, the implementation of the design, testing and results before concluding and evaluation the coursework and the groups achievements.

The tasks given to each group was split into 2 separate parts. The first was to develop a behaviour on a single E-Puck. Such initial ideas proposed by Dr. Meng, included love where the E-Puck would follow close to, but without touching an object, or where the E-Puck would try to avoid objects. More of behaviours will be spoken about throughout this report in greater detail.

The second task included using 2 E-Pucks. One of the E-Pucks was tasked with following a human hand but not other objects, whilst the other was to follow the first E-Puck closely without touching it. This second E-Puck would imitate the love behaviour spoken about previously.

2 Background

The robotics association industry defines robotics as "a robot is a re-programmable, multi-functional, manipulator designed to move material, parts, tools or specialised devices through variable programmed motions for the performance of a variety of tasks". according to that definition any device that is programmed to preform variety of tasks is classified as a robot. Most of the robots consists of :

- Physical body
- Actuators
- Sensors
- Controller
- Processor
- Software

Those components are commonly used when designing and developing a robot. A good design is the one who best utilizes these components to reach it's goals effectively.

2.1 Behaviours

A robot Behaviour is defined by how it's motor action will be changed to perform a certain action according to it's sensor reading.Robots have three main control architecture:

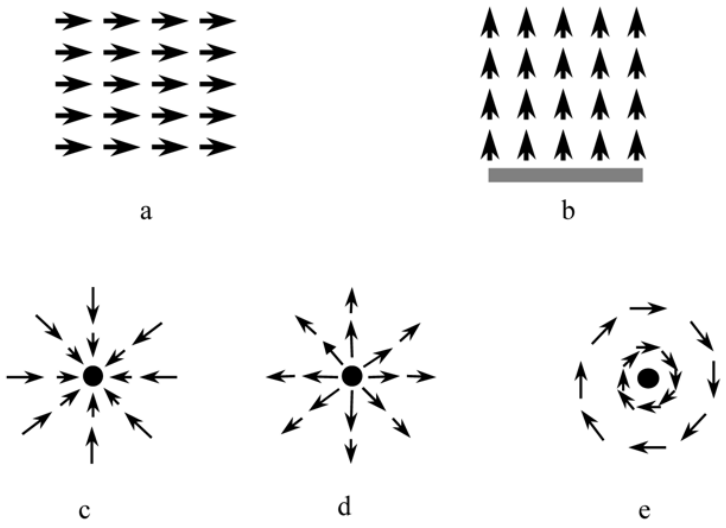

Figure 1: Five Main Potential Fields

- Deliberative approach
- Reactive approach
- Hybrid approach (Deliberative and Reactive)

The Deliberative approach requires high-level of intelligence and has slow response time. On contrary the reactive approach require simple processing and has real-time response. Designed behaviour of a report will require multiple function to be executed together. A combination of behavioural functions might not achieve the anticipated repose towards a change of the environment, to solve this problem a coordinator function is implemented to ensure correct behaviour of the robot. In designing coordination function there are two main strategies:

- competitive: In which one behaviour overshadows any other behaviour and should be executed solely.
- cooperative: In which a collection of behaviour is executed to achieve a certain goal.

Any Behavioural approach for robots is represented as a vector and to perform cooperative coordination between behaviours we use vectors addition. The main potential fields are uniform, perpendicular, attraction,repulsion and tangential. As Shown in 1:

1. Uniform means that robot will move in one direction.
2. Perpendicular means that robot will move in a direction 90 degrees from the object.

Figure 2:

3. Attraction will make the object go towards the object.
4. Repulsion the robot will move away from the object.
5. Tangential when implemented will make the robot rotate and the edge of the object's perimeter.

2.2 E-Puck

E-Puck robots is a small size educational robot which is designed to be flexible and have a desktop size. It's also a low cost robot due to the choice of the components used. It's user-friendly and interactive. It was designed by Martin Stefanec from the artificial life lab of University of Graz [2].

It includes a wide range of sensors and actuators. Sensors include infrared-sensors which can be used to detect objects and ambient light. Motors to control the movement of the robot. For visual communication the robot is has 8 LEDs and for audible communication it has a speaker.

2.3 HSV

HSV stands for Hue, Saturation and value. It's a cylindrical representation of colours, starting at red in 0 degrees, green at 120 degrees and blue at 240 degrees. the vertical axis which is value represents colours ranging from to neutral to black.

2.4 Skin Colour

Skin detection in HSV tends to be more accurate than RGB. For efficient skin color detection RGB image is converted to HSV as HSV relates more to skin

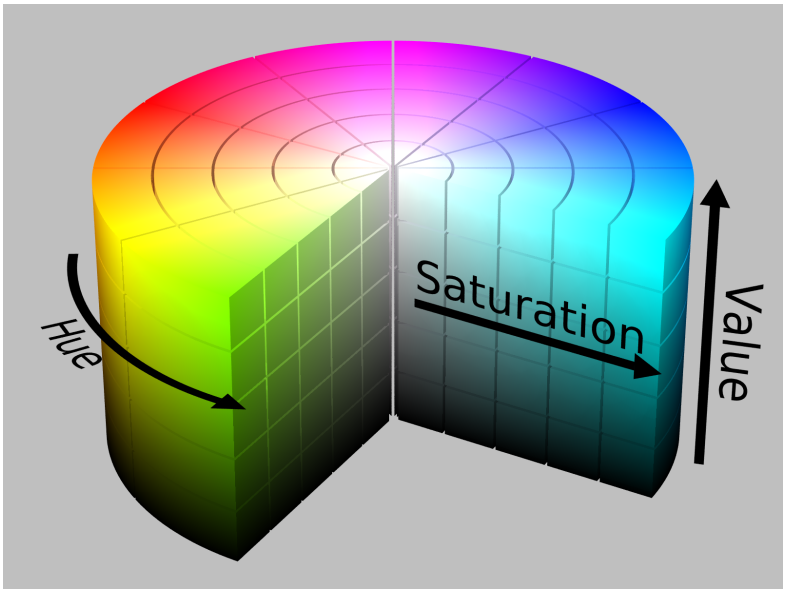

Figure 3:

colour perception. In Hue skin colours varies from 0 to 50 degrees [1].

3 Design

This section will explain how both tasks A and B will be completed, giving diagrams and flowcharts of how the E-Pucks will carry out a particular task.

3.1 Task A

To begin designing a solution to the tasks set out in section 1, one must first decide upon the different behaviours to be implemented for the tasks. A relatively simple task to be implemented, which would be beneficial to both the first and second task, would be to implement a love behaviour.

Section 2 discussed how each behaviour would perform, illustrating that the love behaviour would follow but not touch the leading object. A second behaviour to be implemented would be an adaption of the aforementioned love behaviour, although instead of the E-Puck following an object it would instead follow a bright light placed before it. The E-Puck would use both the camera to discover any spots of light that have a much higher intensity than its surroundings.

One third and final possible behaviour to implement, providing time permits the group to do so, would be to to implement a obstacle avoidance behaviour. The behaviour which attempts to avoid any nearby objects whilst moving in a particular direction. When it approaches an object it changes its direction to move away from the object.

The first and final behaviours rely heavily on the infrared senses situated on around the edge of the E-Puck. The E-Puck will read in from the infrared sensors,

each returning a voltage reading to the chip. This reading can then be used within a formula to calculate the distances to a nearby object. When an object is discovered nearby, the E-Puck must either turn to face it or alter it's direction to move away from it, for the love and obstacle avoidance behaviours respectively. The E-Puck is then required to move forward at a fixed speed until either the object is very close, but not touching for the love behaviour or no longer detected for the hate behaviour.

To create the second behaviour of an attraction to light the E-Puck must be implemented in a similar way to the previously mentioned behaviours, although instead of reading the infrared sensor value for distance one will measure the amount of ambient light falling onto the device.

3.1.1 Flowchart

3.2 Task B

Task B requires the group to implement 2 different E-Pucks and cause each to do their own tasks. One E-Puck will be required to follow a hand whilst the other E-Puck will be required to follow the first E-Puck. This may seem similar after implementing the behaviours from task A, although many issues could arise with this task. These issues will be discussed toward the end of this section.

Since the love behaviour will have already been implemented once the implementation of task B begins it would be logical to make use of these behaviours to save time. Therefore to obtain the the desired output of the second E-Puck (the following of the first E-Puck), one may use this behaviour and achieve the required result.

For the first E-Puck, the E-Puck which will be following a human hand, the group will have to use both the camera and infrared sensors on the E-Puck and consult the research performed within section 2 surrounding the colour of human skin.

The E-Puck will begin by discovering any near-by objects using the infra-red sensors before turning the front camera towards any discovered objects. The front camera will then read in the image of the object. Removing a few rows of pixels from the image, for fast processing, the pixels will then be processed to find any required colour that the E-Puck is looking for, the colour of a hand. This processing will be done in the HSV colour plane as to reduce the impact lighting has on the colour of an image.

3.2.1 Flowchart

4 Implementation

This section will describe how each of the tasks mentioned in section 3 have been implemented, explaining the functions within the code, and any discrepancies between the design and final implementation.

Selector	Function
0	run_breitenberg_follower
1	finding_light
2	avoid_light
3	run_breitenberg_shocker
4	followHand

Table 1: A table to show what function is ran for each selector.

```
selector=getselector();
if (selector==0) {
        run_breitenberg_follower();
} else if (selector==1) {
        finding_light();
} else if (selector==2) {
        avoid_light();
} else if (selector==3) {
        run_breitenberg_shocker();
} else if (selector==4) {
        followHand();
} else{
}
```

Code Snippet 1: Descriptive Caption Text

The design was gradually implemented in stages, building up to the final completed solution to each task. To make the project easier to implement the demo project provided on the E-Puck[2] website was used as a template.

4.1 Main File

Within the demo project one can find the main file. This main file starts by finding the position of the selection, a single hexadecimal digit. This selector then decides which function will be called. This becomes very useful to the groups project as then each behaviour needed to be implemented can be ran when a unique selector is selected. Table 4.1 clearly shows the possible choices to the user with the code being displayed in the code snippet 1.

The functions shown in table 4.1 will each be discussed in detail throughout this section.

4.2 Breitenburg Follower

The 'run_breitenburg_follower' function is a function that was taken from the demo project mentioned previously

5 Results & Testing

6 Conclusion

References

[1] Oliveia V.A., Conci A. Skin detection using hsv color space, 2016.

[2] Pugh J., Cianci C., Klaptocz A., Magnenat S., Zufferey J.-C., Floreano D. Mondada F., Bonani M., Raemy X. and A Martinoli. The e-puck, a robot designed for education in engineering, 2016.