Embodied Reactive Agents

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***Abstract*—Throughout this article we talk about what we have learned in the Intelligent Systems laboratory class where we study the embodied and reactive agents.**

***Keywords*—embodied agent, reactive agent, BrickPi, Lego Mindstorm, etc.**

I. Introduction

The embodied concept has been used in cognitive science lecture since mid-1980s as it can be seen in different concepts in investigations like embodied mind, intelligence, action, cognition…

The embodied systems, according to Riegler. A, they have structural coupling, they should synchronize to their environment, they can have simulated or physical body.

According to Brooks R. , environment is an important part of the cognitive system, it is important to let robots sense their dynamic world, as a result they become intelligent. [1]

II. Embodied Agents

According to Ziemke T. there are six different notions of embodiment:

A. *Structural Coupling*

It is all about the interactions between the agent and the environment

B. *Historical Embodiment*

History of the interactions between the agent and the environment which also has effects on the cognitive systems.

C. *Physical Embodiment*

The embodiment agents need a physical body composed of sensors and actuators.

D. *Organismoid Embodiment (organism-like body)*

Physical bodies that are similar in sensorimotor functionality as the so called living bodies.

E. *Organismic Embodiment*

Living bodies able to perform self-organization

F. *Social Embodiment*

The state of body rises with any social interaction.

III. Reactive Agents

A Reactive agent is an agent that perceives its environment and reacts to its timely fashion. [2]

The action functions in reactive agents have little to do with computation. The reactive agents are little soldiers whose actions are selected for them. It is the programmer who acts like the "general" and programs the different instructions and orders that the agent has to follow.

For a complex "human-like" reactive agent it would require big amounts of memory because there is where all the different instructions would be stored. It has to be noted that the programmer has to have a great perception of the environment for the agent to have an accurate response to the different situations the reactive agent has to face off.

IV. Work Developed During Practical Classes

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A. *Embodied Agents: Introduction To BrickPi.*

The BrickPi is an interface that connects on one side the RaspaberryPi, on the other side to the Lego motors and sensors. The RaspaberryPi will send the orders written to the BrickPi who will process those orders and send it to the motors and sensors.

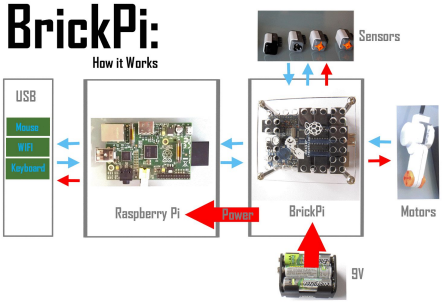

Fig. 1: BrickPi.

- Preliminary Task: Testing the Robot
  For testing the robot there is a file, robot.py, that has to be downloaded. This file contains a program that will allow the robot to move forward a few seconds and to activate the fan.

- Calibration Task: Moving Straight
  The power on each wheel has to be recalibrated to allow the robot to move straight. If not, the robot will move slightly to the left or right each time it tries to move forward.

- Task 1: Rooms
  The first task consist in write a program that allows the robot to navigate in a simple environment composed of corridors and rooms.

- Task 2: Wall Bot
  In this task, the robot has to navigate within a room without touching any of the walls using only the ultrasonic sensor.

  This task will be completed by a second one in which the robot will navigate, instead in the labyrinth, in a sumo ring where instead of walls, there will be a white line surrounding the ring. This light will be detected by the light sensor.

- Task 3: Sumo Bot
  The last task will consist in a combination of the previous ones. The robot will be placed in the sumo ring and it will have a pile of cans as its opponent. With its light sensor, the robot has to detect the line surrounding the ring and with the ultrasonic sensor, it will detect the cans. The robot task is to throw the cans out of the ring.

B. *Embodied Agents: Lego Mindstorm (I).*

- Task 1: Light Detection
  In a mat, the robot should be able to move forward and record the readings from the light sensor in a file, to later be plotted in a figure.

- Task 2: Line following
  The task is to program the robot to follow a black line in a white background with only the light sensor. It is important to make sure the robot follows the line carefully.

- Task 3: Line following with obstacle avoidance
  The task is similar of the previous one with the catch that this time, there will be an obstacle on the way and the robot has to be able to avoid it and then return carefully to its original path.

C. *Embodied Agents: Lego Mindstorm (II).*

- Task 1: Exploring Vehicle Behavior
  The speed of the vehicle has to vary according to the light sensed by its light sensor in each motor. That means, both motors have to be adapted to each sensor to move according each perception.

- Task 2: Braitenberg's Vehicle 3
  The sensor will be inverted in this task, just like what Braitenberg did with his Vehicle 3 in his experiment.

D. *Reactive Agents:.*

A Fire-Fighting Embodied Agent

Here the robot has to be able to completely explore all the rooms in the labyrinth with its sensors, find a candle in any of the rooms, and be able to extinguish the fire using the fan attached to the robot.

V. Results Obtained

A. *Embodied Agents: Introduction To BrickPi.*

- Task 1: Rooms. In this task, we did not have any problems to solve the exercise, because it was very simple and we think is a good introduction to BrickPi. [3]

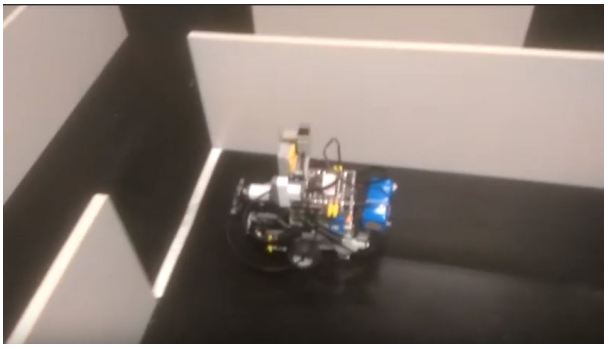

Fig. 2: Robot coming out of the first room.

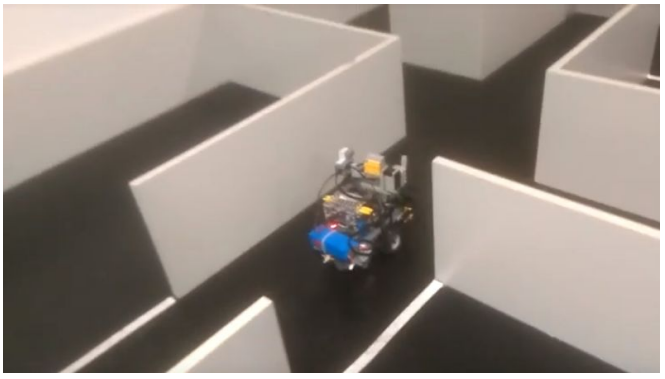

Fig. 3: Robot in the first corridor.

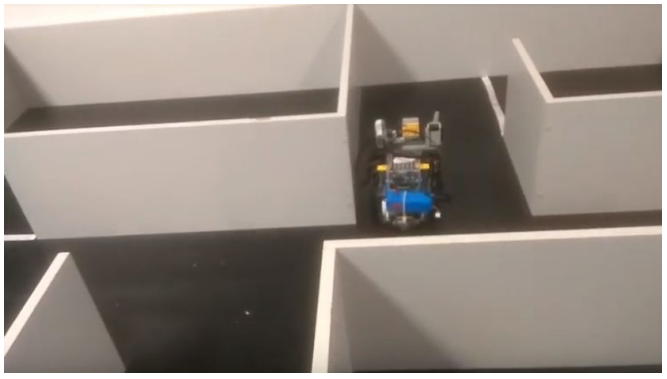

Fig. 4: Robot in the second corridor.

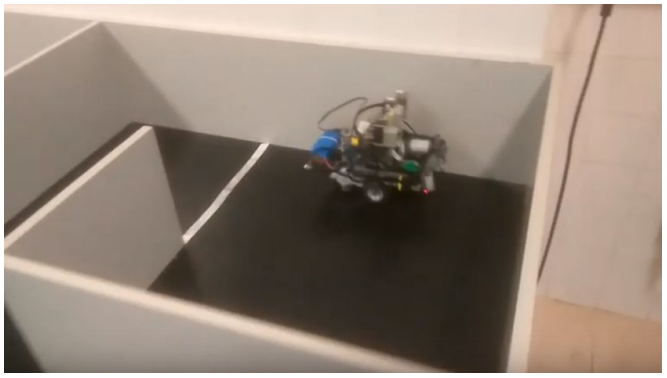

Fig. 5: Robot entering the second room.

- Task 2: Wall Bot. This second task was useful in order to learn about the sensors. [4]

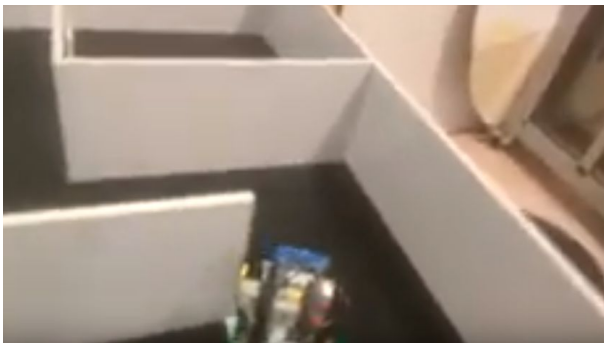

Fig. 6: Robot exploring the rooms with proximity sensor (I).

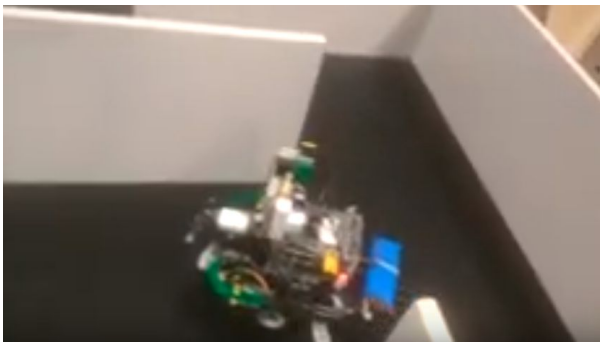

Fig. 7: Robot exploring the rooms with proximity sensor (II).

Fig. 8: Robot exploring the rooms with proximity sensor (III).

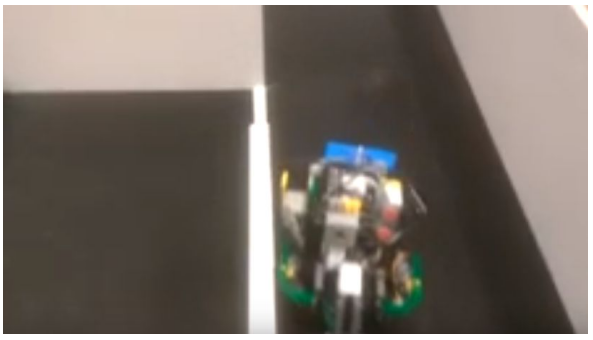

Fig. 9: Robot exploring the rooms with proximity sensor (IV).

- Task 3: Sumo Bot. In the first picture (Fig. 10), the robot is wandering around the ring searching for the adversary. The next one (Fig. 11), the bot has found the adversary and is going to push it out of the ring (Fig. 12). [5]

Fig. 10: Robot wandering on the ring.

Fig. 11: Robot finding the adversary.

Fig. 12: Robot pushing the adversary out of the ring.

B. Embodied Agents: Lego Mindstorm (I).

- Task 1: Light Detection. It was an easy task for starting with the light detection sensor, and with the values obtained in the graphic (Fig. 13), We can calibrate the values for the sensor when it detects black or white.

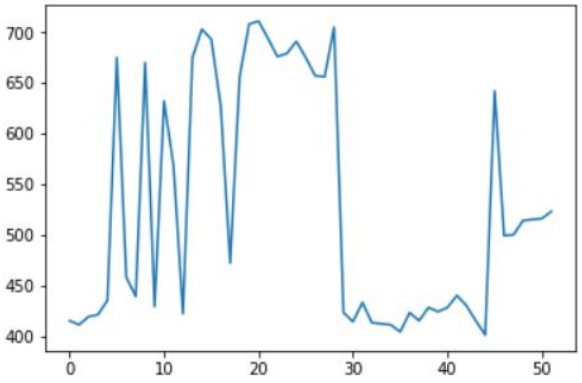

Fig. 13: Graphic with the values obtained during the first task. The horizontal axis represents the time, and the vertical axis represents the value of the sensor..

- Task 2: Line Following. The functioning of this program is very simple, if the sensor detects white, the robot turns left, and if it detects black, turns right. The result is a robot that follows the line. It is slow, but it works perfectly. [6]

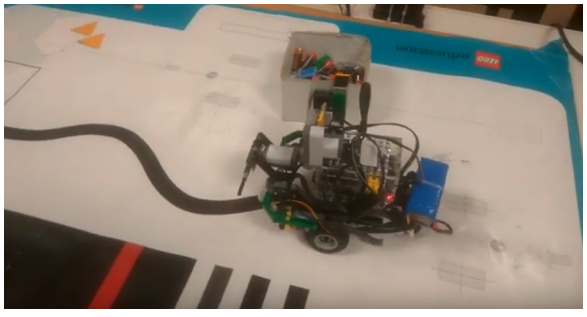

Fig. 14: Robot at the starting point .

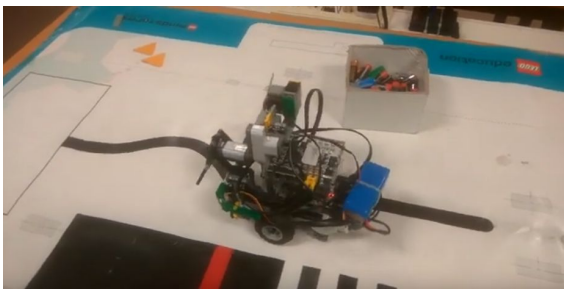

Fig. 15: The robot is following the line.

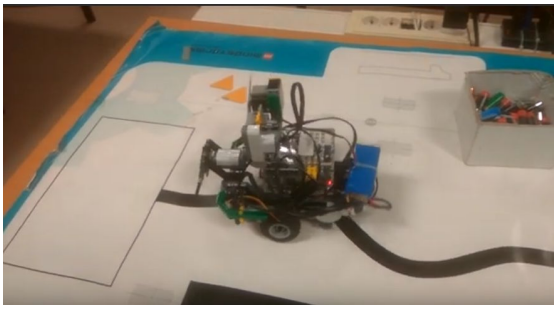

Fig. 16: The robot completes the challenge.

- Task 3: Line following with obstacle avoidance. In this case, the robot avoids the obstacle without any problem when the touch sensor detects it. [7]

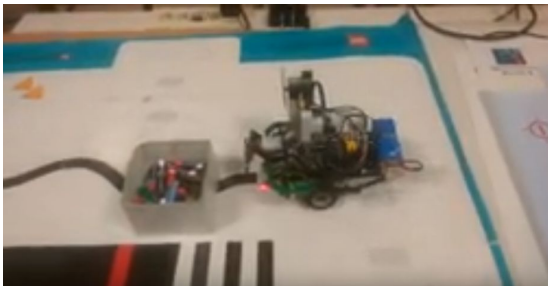

Fig. 17: The robot following the line.

Fig. 18: The robot detects the obstacle and it goes back.

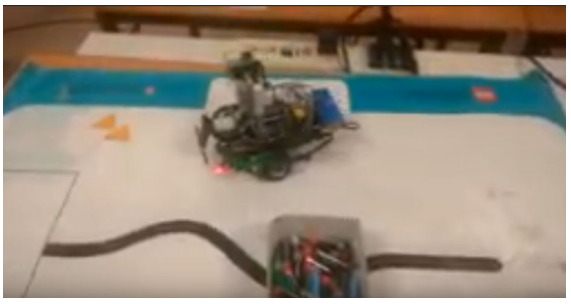

Fig. 19: The robot surrounds the obstacle.

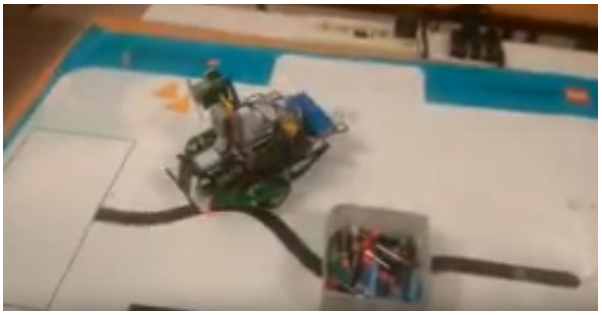

Fig. 20: The robot finds the line again.

C. *Embodied Agents: Lego Mindstorm (II).*

Due to time related issues, we weren't able to finish this part.

D. *Reactive Agents:*.

- Task 1: Wall Following. This task was difficult, because we had to make the robot enter all the rooms, but the central room was a problem. Finally, we solved that problem by making the robot not to follow always the same wall.[8]

Fig. 21: The robot at the starting room.

Fig. 22: The robot entering the second room.

Fig. 23: The robot exploring the second room.

Fig. 24: The robot getting out of the second room.

Fig. 25: The robot in the corridor going to the third room.

Fig. 26: The robot at the third room.

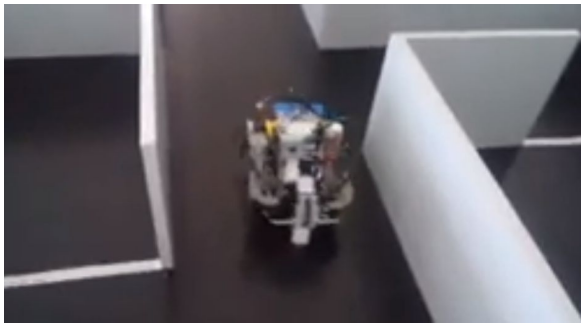

Fig. 27: The robot at the starting room.

Fig. 21: The robot at the starting room.

VI. Conclusion

This sessions about embodied and reactive agents have been interesting and entertaining. We have learn about the use of sensors in order to reproduce behaviors that seems intelligent actions and reactions depending on the environment.

Furthermore, we have learned to use Raspberry pi boards with BrickPi in order to program all those behaviors.

References

[1] http://www.manoonpong.com/talk/Bio-RobotDesignTowardsEmbodimentSystems.pdf

[2] https://www.igi-global.com/dictionary/agent-technology/35268

[3] https://youtu.be/fQzE8W0Rc4Y

[4] https://youtu.be/k8JGR8elc0Q

[5] https://youtu.be/PR4aw73SAH4

[6] https://youtu.be/fQRLkFH2bIQ

[7] https://youtu.be/HfqXiiXwWXY

[8] https://youtu.be/yGvle0dU_hQ