A Behaviour-Based Robot

AINT503 mini-project

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***Abstract*—the robot is implemented with a behaviour-based robotics approach. It involves a very simple approach in programming main tasks – to avoid obstacles; move forward. But, when tested in the arena, it showed behaviours like emergence, stigmergy and embodiment which wasn't planned in the tasks coded.**

Keywords-* *behaviour-based; stigmergy; emergence; embodiment.

I. INTRODUCTION

This paper is based on a behaviour-based robot mini-project where the robot's nature must be coded using behaviour based approach.

The paper begins with a brief background of behaviour-based robotics. Consequently, describing the robot's design and construction followed by discussion of results.

II. BACKGROUND

A. Problems of the Classical AI Approach:

Classical AI approach works well when the situation is precisely known and works in serial manner. Also, classic approach is less impressive for those systems which include dynamic orientation ability, manipulation and speed [1].

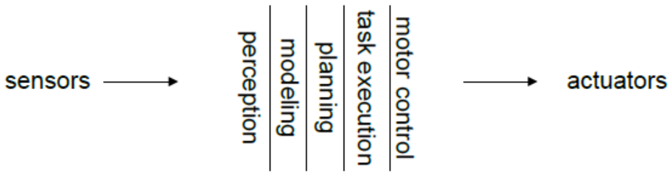

Figure 1: Classic AI approach [3]

B. Behaviour-based robotics to address Classical AI problems:

The behaviour-based approach's result indulges asynchronous set of behaviours and the environment. The key ideas behind this approach are Embodiment, No planning, Situatedness, and Emergent complexity. This gives the flexibility which lacked in classical AI approach. The system is set to be more natural flow towards interacting with the environment [1, 3]. Braitenberg vehicles [2] are one of the examples of behaviour-based robotics which observes the above mentioned approaches.

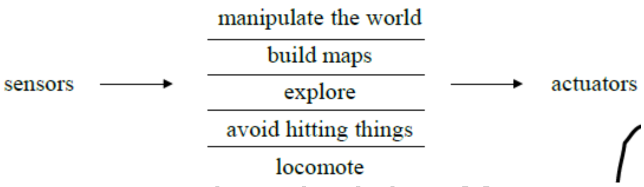

Figure 2: Behaviour based robotics [3]

C. Braitenberg Vehicle Experiment:

This is a simple behaviour-based robot where light sensors are connected to motors. In vehicle 2a, each sensor is connected to the motor on the same side. This vehicle behaves like it is scared of light. But, this behaviour of vehicle 2a was not programmed specifically. In vehicle 2b, each sensor is connected to the motor on the opposite side. This vehicle behaves exactly opposite to that of first vehicle 2a – attracted towards the source [2].

The robot used in this mini-project implements vehicle 2a's functionality.

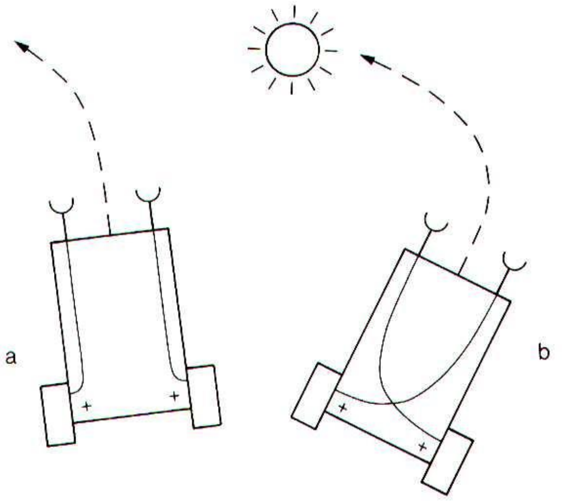

Figure 3
Vehicles 2a and 2b in the vicinity of a source (circle with rays emanating from it). Vehicle 2b orients toward the source, 2a away from it.

[3]

III. METHODS

Lego Mindstorms NXT robot construction kit was used to construct the robot. The robot has two active light sensors in the front: at left and right facing away from the body in an angle. This design has 4-wheels. Though, works like a 3-wheel design, the 4th wheel is included to take the load of the body weight at the front, and is aligned in the same line as front two wheels.

A. Design Explanation:

- **Light Sensors Position.** Project specification included that the light sensors pointed sideways and not front. Hence, they are positioned in an angle sideways.
- **Fourth wheel.** Robot's initial design consisted of 3 wheels. However, while testing it was found that the body weight at the front was causing trouble for smooth movement.
- **Low ground clearance.** The robot's design inspiration is a combination of crab and a scorpion. Also, when the robot is in the experiment arena, it is designed to avoid any Ping-Pong balls from getting stuck between the wheels.
- **Motor wires as tail.** To give more natural approach to the robot design, the motor wires seemingly works as a tail.

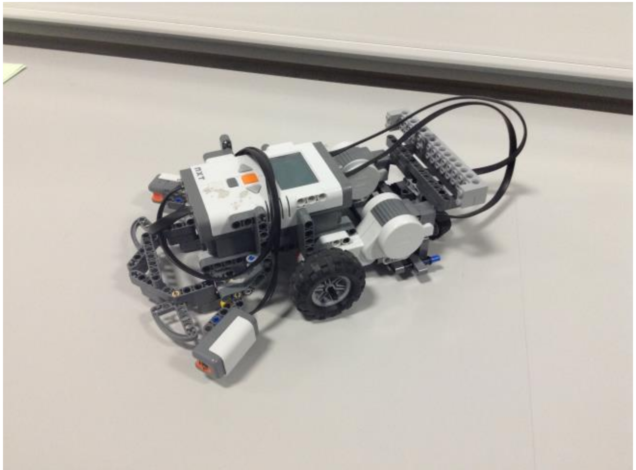

Figure 4: Robot's physical design

B. Code Structure:

NXC (Not eXactly C) programming language was used to code the robot. NXC supports multiple tasks. A task in NXC directly corresponds to a thread in NXT. Though motor runs one task at a time, other system tasks are run continuously.

- **SetRight.** This task takes the input value from the right sensor. And, calculates the corresponding value with respect to threshold value which in turn sets the right motor to forward or backward movement based upon the position from obstacle.
- **SetLeft.** This task takes the input value from the left sensor. And, calculates the corresponding value with respect to threshold value which in turn sets the left motor to forward or backward movement based upon the position from obstacle.
- **Forward.** This task sets the motor to forward motion based on the input values (dynamic) from both the sensors.
- **RandomMovement.** This task sets the robot into random movement based on both the sensor light inputs.

C. Code Expectations:

Like vehicle 2a from figure 3 [2], this robot has tasks set for right and left motors which are to move away from the source, in this case, it is to avoid obstacles using the inputs from the sensors.

The random movement task of the robot is similar to that of crab/ scorpion which is not definitive.

To observe the tasks functioning in a natural flow, usage of any delay to motors are avoided.

A threshold value is used to gauge the need to deflect an obstacle in SetRight and SetLeft tasks by using sensor values to set specific motors movement using mathematical expression.

So, combining these code expectations, the main objective of the code is to make the robot avoid obstacle and move forward otherwise.

IV. RESULTS

A. Observation in Test Environment

The test environment was a 2 meter squared area filled with ping pong balls. According to the code expectations, the robot was expected to move around in the test arena and avoid obstacles. However, the produced results interpret different set of behaviours.

Whenever the robot was in a free space, it moved forward but with a random pace and considerable direction shift which is a dynamically changing factor. However, when it was surrounded by the ping pong balls, it was scared to move ahead. While it was functioning on SetRight and SetLeft tasks simultaneously, it was observed that the robot started to build a nest like area [5].

Figure 5: Robot Nest

Another feature noticed during this testing was that, after retreating from the ping pong balls, the robot moved forward and seemed like pushing the balls forward similar to that of a dog when it encounters some crawling insect – first the dog goes near, then retreats, and again surges forward to touch the crawling insect [5].

When the robot was observed building a nest like area, it tends to stay within the area whilst it expanded the nest rather than exploring. However, interestingly, the robot did show the behaviour of exploring and returning back in the same path traversed for couple of times [4].

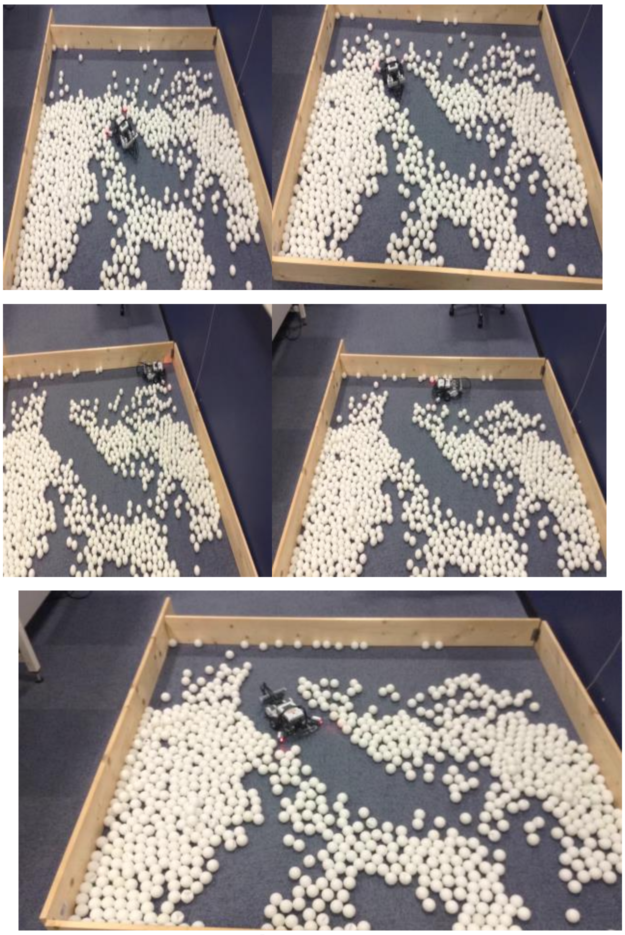

Figure 6: Observing Stigmergy

The body structure also played a part in helping the robot to achieve certain behaviours. Whenever the robot performed the above tasks, the body and the tail were interacting with the ping pong balls that surrounded regardless of no such specific task defined in the system [4, 5].

V. Conclusion

Lego Mindstorms was used to build a behaviour-based robot which was coded in NXC. When the robot was tested in the test arena which had ping pong balls, certain behavioural features were noticed.

From the results section, going through the observed behaviours, it can be concluded that the robot showed certain features of emergence i.e. how SetRight and SetLeft tasks helped achieve a new behaviour. Also, the body design and its interaction with the environment regardless of the tasks running in the system showed the embodiment nature of the robot.

Going through the exploring nature observed – explained in results section. It can be concluded that robot possesses stigmergy. It was also observed that robot system software which was injected with four different behaviours. The robot orchestrated this approach with the fusion of behaviours.

This robot can be further infused with various behaviours along with usage of different sensors to test on various behaviours that could emerge.

References

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