LEGO MINDSTORM EV3 – A ROBOT WHICH LOCATES A BALL IN A PLAY FIELD AND SHOOT GOALS

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INTRODUCTION

LEGO Mindstorm Ev3 is a programmable robotics kit released by Lego. The “EV” stands for “evolution” and 3 represents the third version of the Mindstorm products line. The LEGO Mindstorm EV3 is the successor of Lego Mindstorm NXT.

Using the LEGO Mindstorm EV3, we can build, program and command our own LEGO robots. We can combine the LEGO elements such as the bricks, motors and sensors, to perform our required tasks. It is also possible to build robots which locates a ball in a play field and shoot goals, the aim of this assignment.

Lego mindstorm EV3

Lego mindstorm EV3 is a graphical programming environment that comes bundled with the EV3. With careful construction of blocks and wires to encapsulate complexity, EV3 can be used for real-world programming. Parallel "sequence beams" are actually parallel threads, so this software is quite good for running a handful of parallel sense/respond loops (example: wait 60 seconds, play a "bonk" sound at low volume if battery is low, loop), or blending autonomous control with Bluetooth or other "remote control". The language supports virtual instruments for all LEGO branded and most 3rd party sensors/components.

AIM:

To build a robot which locates a ball in a playing field and shoots goals.

FUNCTIONALITY

The EV3 mindstorm robot that we built has 2 main functionalities. They are as follows:

1. Penalty Shootout - Given a ball and placed in front of it, the robot should shoot a goal. A torch light is used to guide the robot to the shootout position.
2. Ball finding and Goal Scoring – The robot must find 5 balls which are in the field and shoot a goal. A torch light is used to guide the robot to the shootout position.

DESIGN

Hardware Components

The Lego Mindstorms EV3 kit includes the following basic components:

1. **Servo motors:**

   The servo motor is a powerful motor which can control within one degree of accuracy. It has built in rotating sensor which can align with the other motors on the robot so that it can follow a straight line with the same speed.

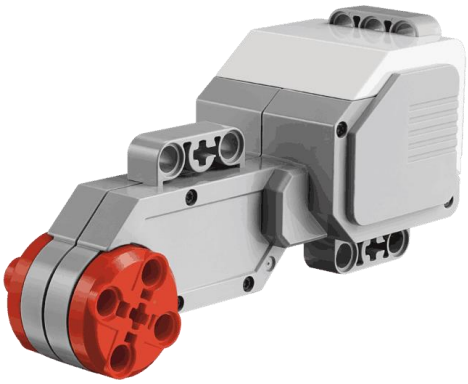


Figure 1 : Servo motor

2. **Touch sensor:**

The touch sensor is a precise tool that detects when its front button is pressed or released. It is capable of counting single presses as well as multiple presses. In the EV3 programming software, a value of 1 is given out when it is pressed down, and a value of 0 is given out if it is not pressed.

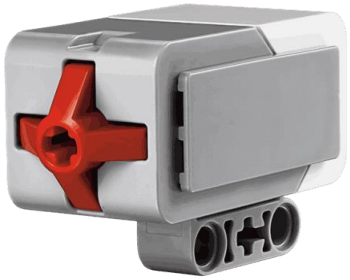


Figure 2 : Touch sensor

3. Light sensor:

The light sensor enables the robot to distinguish between light and dark, as well as determine the light intensity in a room or the light intensity of different colors. In the EV3 programming software, the sensor senses light on a scale of 0 to 100, 100 being very bright and 0 being dark. If calibrated, the sensor can also be used as a distance sensor.

Figure 3 : Light

4. Colour sensor:

The colour sensor detects the colour or intensity of light. It can distinguish between seven different colours and can also detect the absence of colour.

Figure 4: Colour Sensor

5. Programming brick:

The programming brick serves as the power station to the robot. All the sensors are connected to the programming brick using wires.

Figure 5 : Programming brick

Path to be followed by the robot

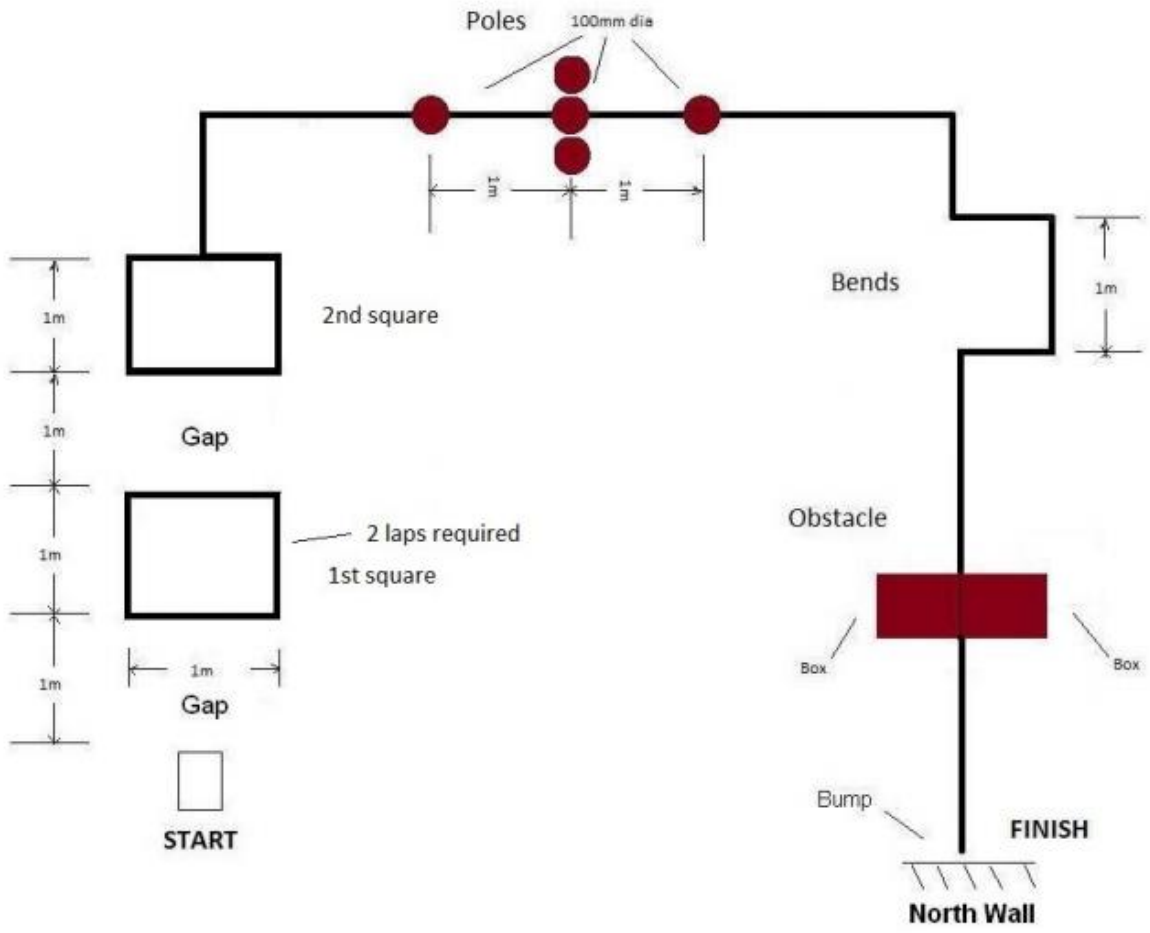
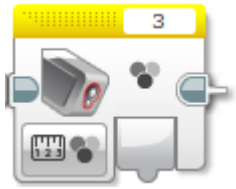
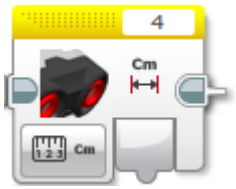
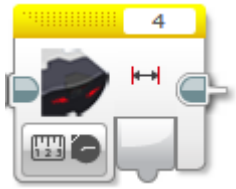
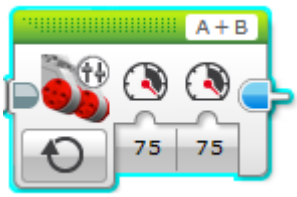
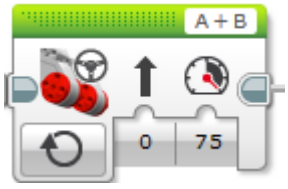
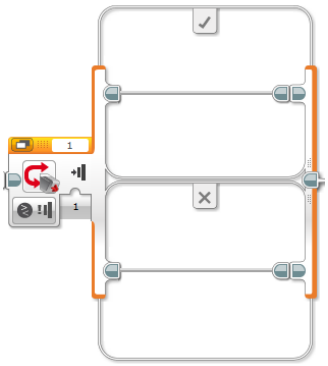
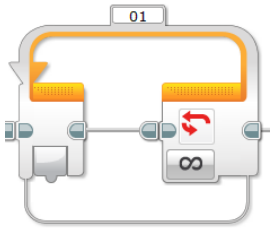


Figure 6 : Robot path and Environment

Software Components

NAME	PICTURE	FUNCTION
Light sensor		Reflected light intensity is measured by the light sensor at any instance.

Ultrasonic sensor		Distance between the robot and object is measured and is used for various operations.
Infrared sensor		Proximity between the robot and object is measured and is used for various operations.
Touch sensor		When the robot touches an object, it is detected by touch sensor.
Move tank		The robot will move with respect to the value given to the motors when this block is executed.
Move steering		Robot will move in a straight line in the specified speed when this block is executed.

Switch		Switch block is triggered by any specified sensor or any other condition and then upper block will be executed if the condition is true and lower block is executed otherwise.
Loop		The block will execute repeatedly for infinite time or until exit condition becomes true.

IMPLEMENTATION

The goal of this project is to design an EV3 mindstorm robot which will follow a white line and avoids any obstacle that is on its way. The robot uses the following sensors to achieve the goal:

1. Light sensor to follow the white line
2. Ultrasonic sensor, Infrared sensor to detect and avoid any obstacle that is on its way.
3. Touch sensor to stop the robot while hitting on wall

Line follower

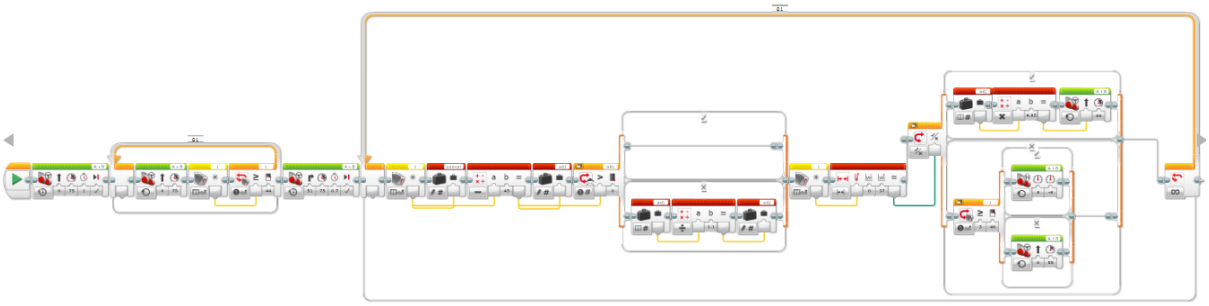


Figure 7 : Line follower

Figure 8 shows the design of line follower in an infinite loop by repeatedly switching on the Color Sensor (as Light Sensor) and testing to see if it is greater than (brighter) than a threshold value. This threshold value should be set approximately halfway between the minimum expected reading near the centre of the line and the maximum expected reading completely over the light coloured floor (we have used "Calibrate" program to measure these). With the threshold at the average of these two numbers, the robot will seek out the right edge of the line, where the sensor sees about half line and half floor. If the reading is greater than the threshold value, then the robot is off to the right of the line, so make a left turn to correct by making B go fast and A go slow. If the reading is less than the threshold value, then the robot is too far from the centre of the line (not over the right edge as desired), so it is corrected with a right turn by making A go fast and B go slow. The sensor test and steering corrections are repeated quickly in the loop (many times per second). Light sensor is the only sensor that is being used for this part. Move tank, Move steering, variable, range, logic, loop, and switch are the other blocks that have been used in addition to light sensor block.

Robot will start moving from start box and go past that gap. Then after reaching First Square, robot should take 2 laps in that square. Then it should go past another gap and reach Second Square.

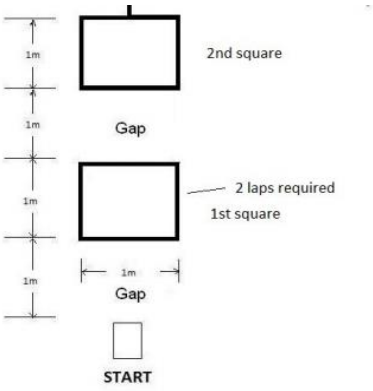


Figure 8 : Line follow and laps

Detecting & avoiding obstacles using ultrasonic and infrared sensors

Detecting and avoiding Poles

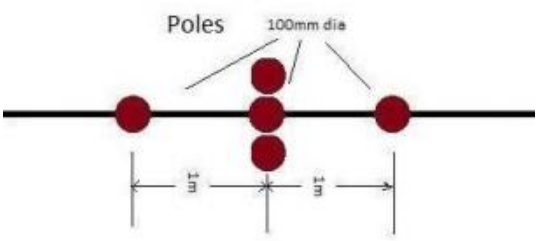


Figure 9 : Poles

These are the poles that robot should go around without hitting or touching them.

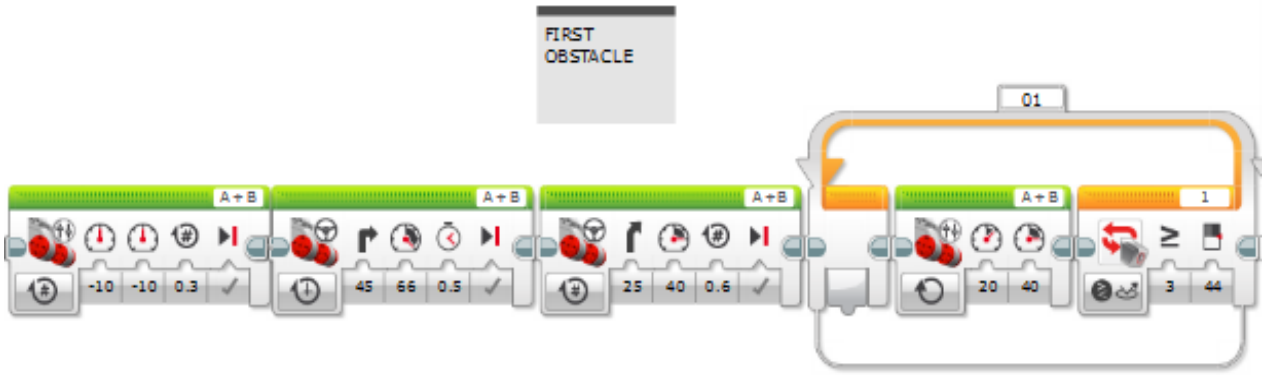


Figure 10 : Detecting and avoiding first poles

Figure 8 shows the code blocks for detecting and avoiding first obstacle which is poles. When the robot is following the white line, it will detect the pole with help of ultrasonic sensor and will move back a little bit before turning left with an angle of 45 degrees while moving at a speed of 66. Once the sensor has turned left infrared sensor will start detecting the pole and if the robot goes towards the pole the infrared sensor will detect and then it will turn away the robot by 25cms from the pole while moving at a speed of 40. The infrared sensor will keep track of the distance from the robot to the pole and will go around the pole. If the robot detect the white line while going around it will start following it. Then when next pole is detected, the same process will be repeated which happened while detecting first pole. The repeating process is placed inside a loop so that it will be executed until the condition is true which is detecting white line. So, whenever the robot goes near the pole, it will turn away. To turn the

robot, A motor is moved slowly and B motor is moved in higher speed which is basically turning left. This condition is given using a move steering block. Thus robot will go around all the pole and will follow the line again when it go pass all the poles.

Detecting and avoiding obstacle

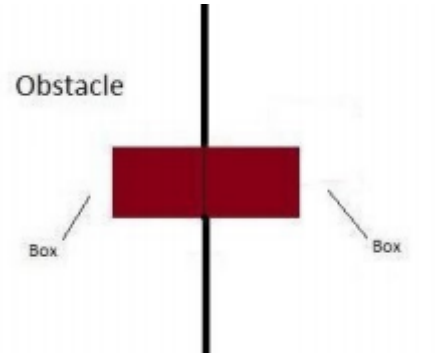


Figure 11 : Obstacle

Robot should go around the box obstacle without touching it. It should come back to white lined path after going around the box.

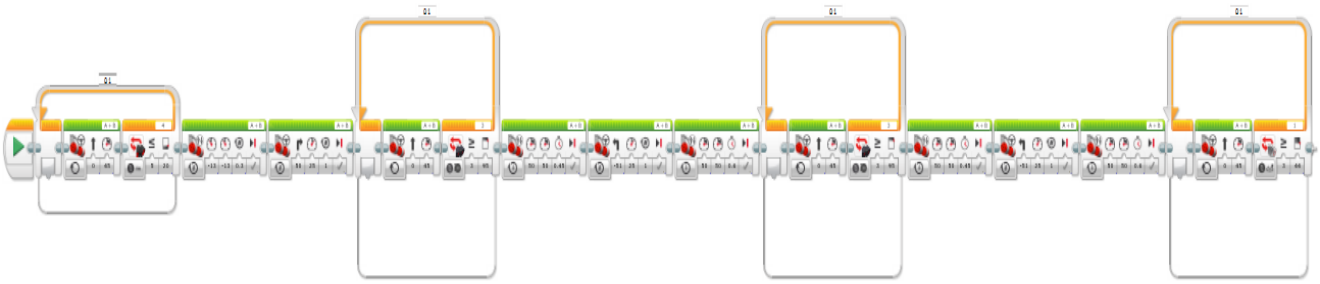


Figure 12 : Detecting and avoiding obstacles

Figure 13 shows about the EV3 code for detecting and avoiding obstacle in the path. Similar to the case of poles, robot will detect obstacle with the help of ultrasonic sensor while following the white line. In this case, robot will turn left by 90 degrees and will keep going straight until the obstacle is in range. For tracking the obstacle, infrared sensor is used. Range of the infrared sensor is 100. So, when the infrared reading is 100, it means the robot went passed the

obstacle. So, the robot will take 90 degree right turn and then the obstacle will be in range again and it will be detected by infrared sensor. The same process which happened while detecting and turning after the obstacle is detected first time will be repeated until the robot reaches white line.

Touch sensor to stop the robot

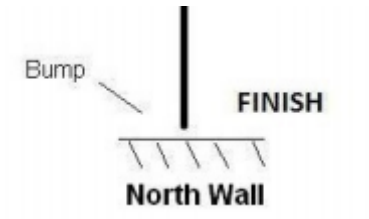


Figure 13 : Stopping wall

Robot should stop after touching the wall.

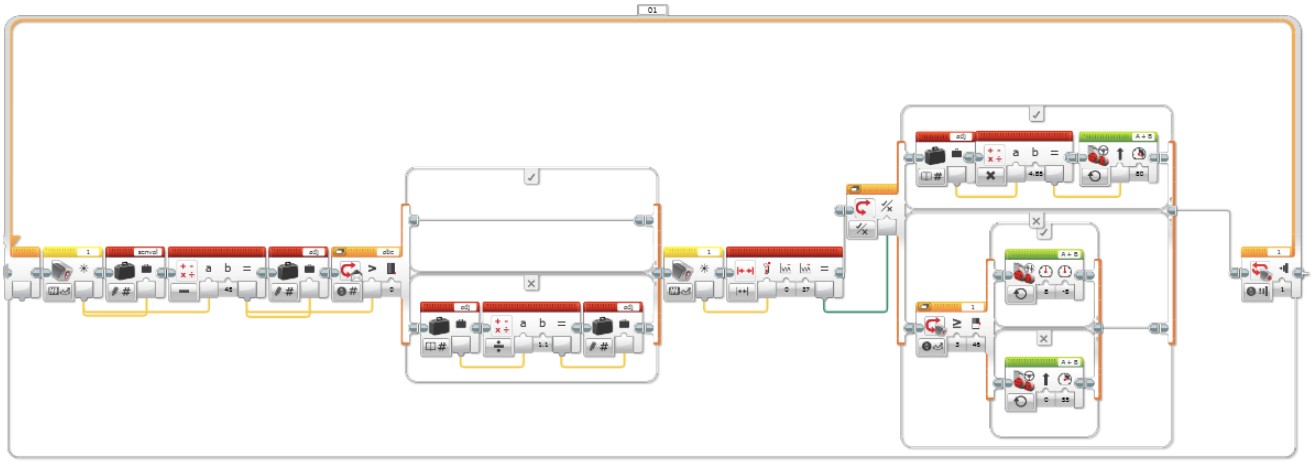


Figure 14 : Code for touch sensor followed by line following

Figure 15 shows the code for the robot to stop after touching the wall. Touch sensor block is followed by line following block. After going past all the poles and obstacles robot will be following the white line. The line follower will be terminated by a touch sensor. In order to detect the wall, touch sensor is used which will make the robot to stop when it touches the wall.