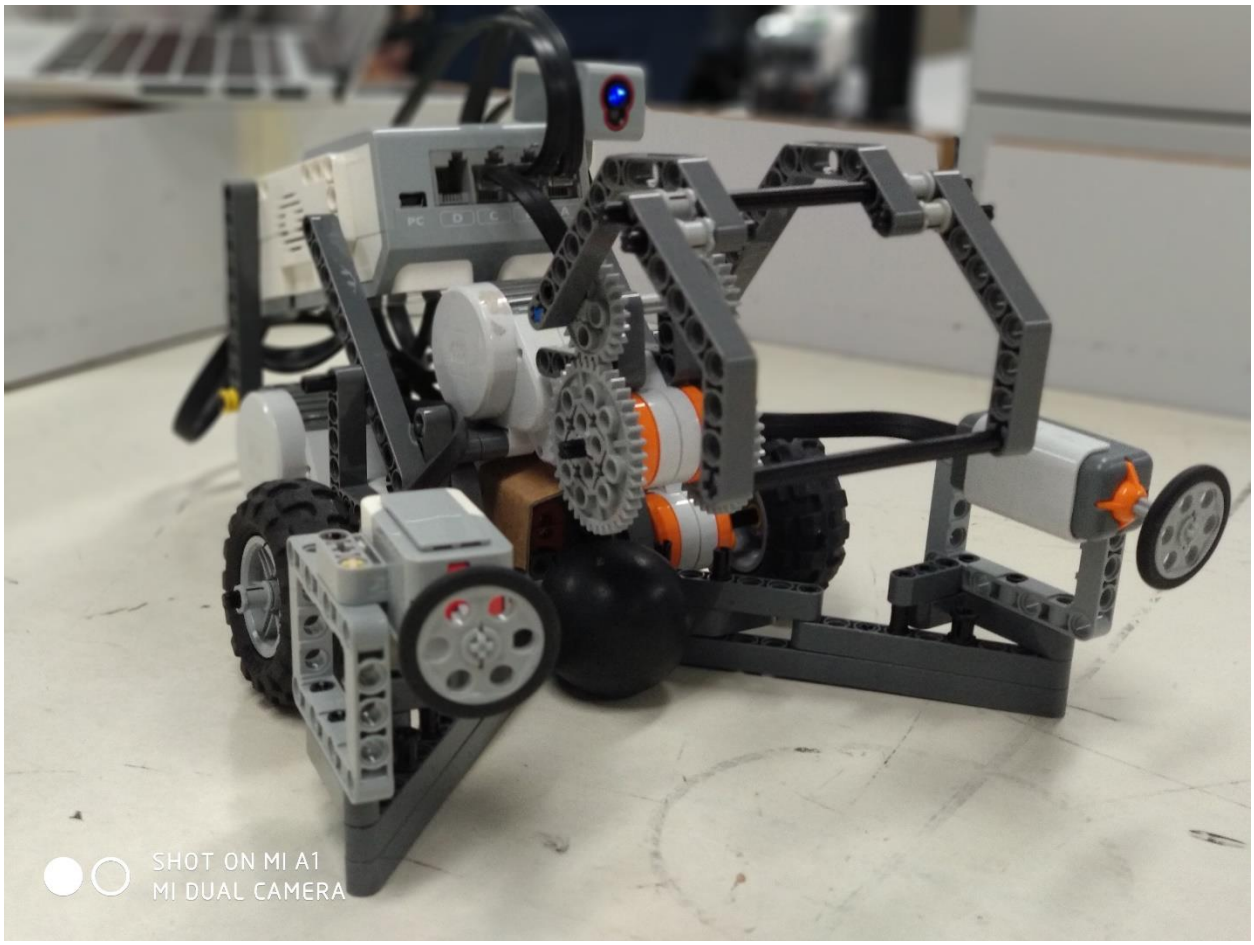
LEGO MINDSTORM EV3 – A ROBOT WHICH LOCATES A BALL IN A PLAY FIELD AND SHOOT GOALS



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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(x3):**

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.

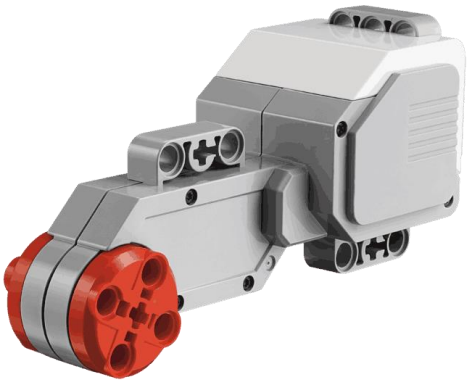


Figure 1 : Servo motor

2. **Touch sensor(x2):**

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(x1):

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 colours. 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 sensor

4. Colour sensor(x1):

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

Playing field

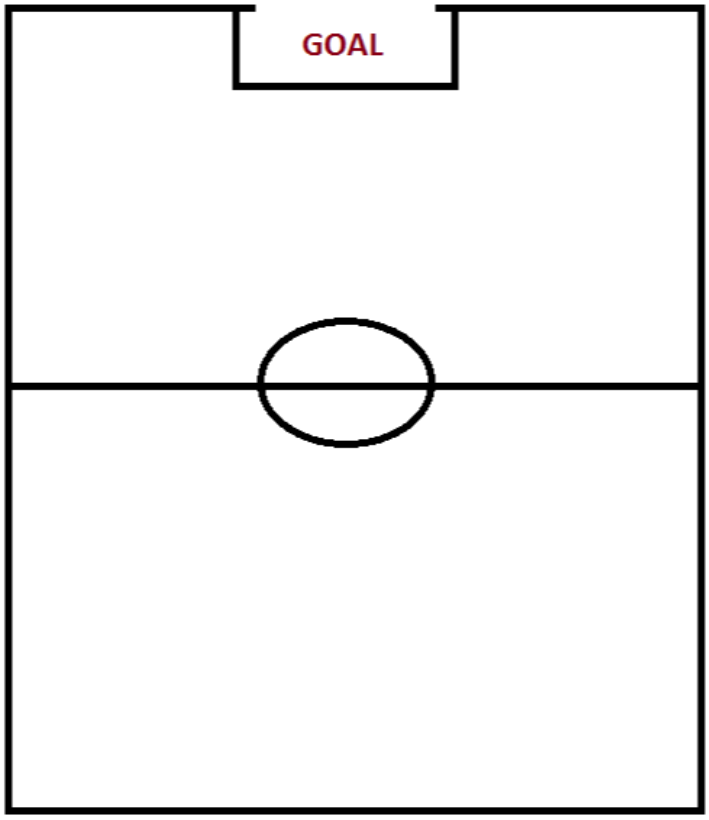
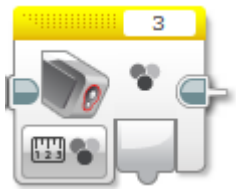
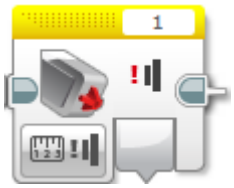
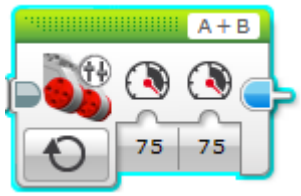
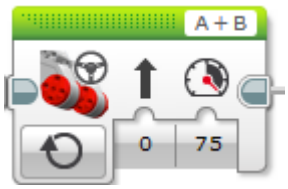
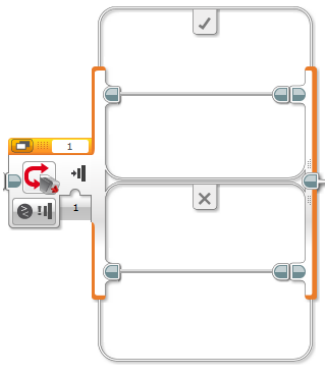
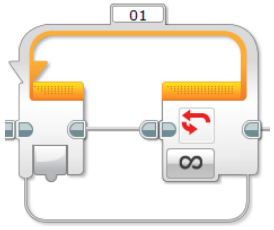


Figure 6 - Playing field

Software Components

NAME	PICTURE	FUNCTION
Light sensor		Reflected light intensity is measured by the light sensor at any instance.
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(speed) 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 when the exit condition becomes true.
Timer		Timer is used to add a delay to any process for a particular time.

IMPLEMENTATION

There are two tasks that has to be performed for this assignment. They are,

Task 1 - Penalty Shootout

Task one involves shooting the ball from a particular position. Ball will be placed inside the arm of the robot. Initial position of robot will be facing away from the goal. When the robot is activated, it will move forward and will turn back after hitting on the wall. Then the robot will move forward again and come to the position from where the goal is to be scored. A torch is used to guide the robot to the penalty shootout position and to line up the shot at goal.

Task 2 – Ball Finding and Goal Scoring

Task two involves searching and collecting the ball in the playing field and shooting the goal. Initially, robot will be in the center of the playing field facing the goal. Five balls are placed in a random position along the playing field. Robot will move randomly over the field and when it finds a ball it will turn towards the goal. Then it is guided using the torch to shoot the goal.

Task 1 - Penalty Shootout

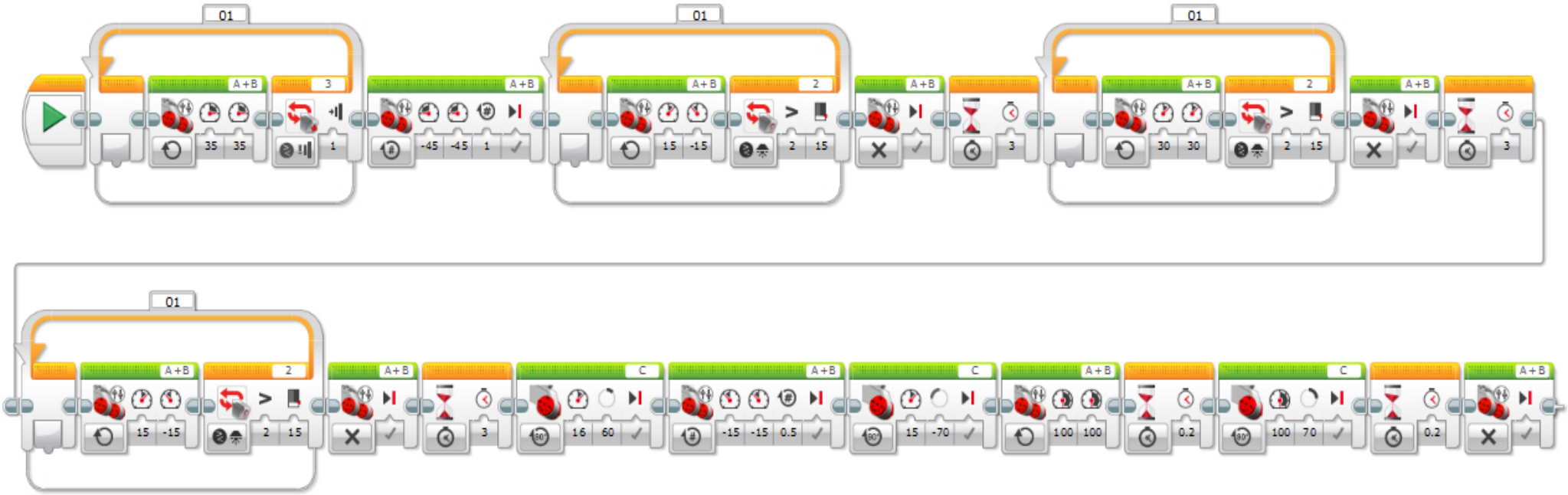


Figure 7 - Code for shooting goals (TASK 1)

Ball is placed inside the arms of the robot. When activated robot will begin to move forward. *Move tank* block is used to move the robot through the servo motors. Move tank block is looped and exit condition for the loop is given as bump sensor sate comparison. (i.e.) when the robot hits the wall bump sensor's state will be changed from 0 to 1 and then the loop will be terminated. Then again, a *move tank* with *on for rotation* condition is used to turn the robot after hitting the wall. Another *move tank* is used to steer the robot towards the goal. This block is given inside a loop and exit condition for the loop is given as comparing ambient light using *color sensor* block. So, when we light the torch on light sensor robot will stop moving and will stay idle for three seconds. *Timer* block is used to stop the motors and so robot will be idle. Then another *move tank* is used to rotate the robot by rotating the servo motors. It is also placed inside a loop so that it will keep rotating until the light sensor detects the torch which is given as exit condition of the loop. *Move tank* is used again to stop the robot and then the robot will stay idle for three seconds again. Then the robot is rotated left side using *move tank* block. It is also placed inside a loop and exit condition for the loop is given as comparing ambient light using *color sensor* block. So, when the torch is lighted the robot will be stop rotating. Then *move tank* block is used and arm of the robot is lifted up which is connected with servo motor C using gear wheels. Then the robot will move backwards by using *move tank* block for 0.5 rotations. Then motor C is rotated so that the arms will closed down again. Now, *move tank* is used to steer the robot and when it goes near the ball servo motor C is rotated so that the arms will rotate with which the ball is shot to goal.

Type and number of Sensors/components used	**Purpose**
Three servo motors are used.	Two of the servo motors are used to move the robot. Another servo motor with which arm is connected used to shoot and cover the ball.
Two touch/bump sensors	Both the sensors are located at the end of the arms and are used to detect the wall when hit.
Two Light sensors	One light sensor is used to detect the ball in the playing field and the other light sensor is used detect the light form the torch.

Task 2 – Ball Finding and Goal Scoring

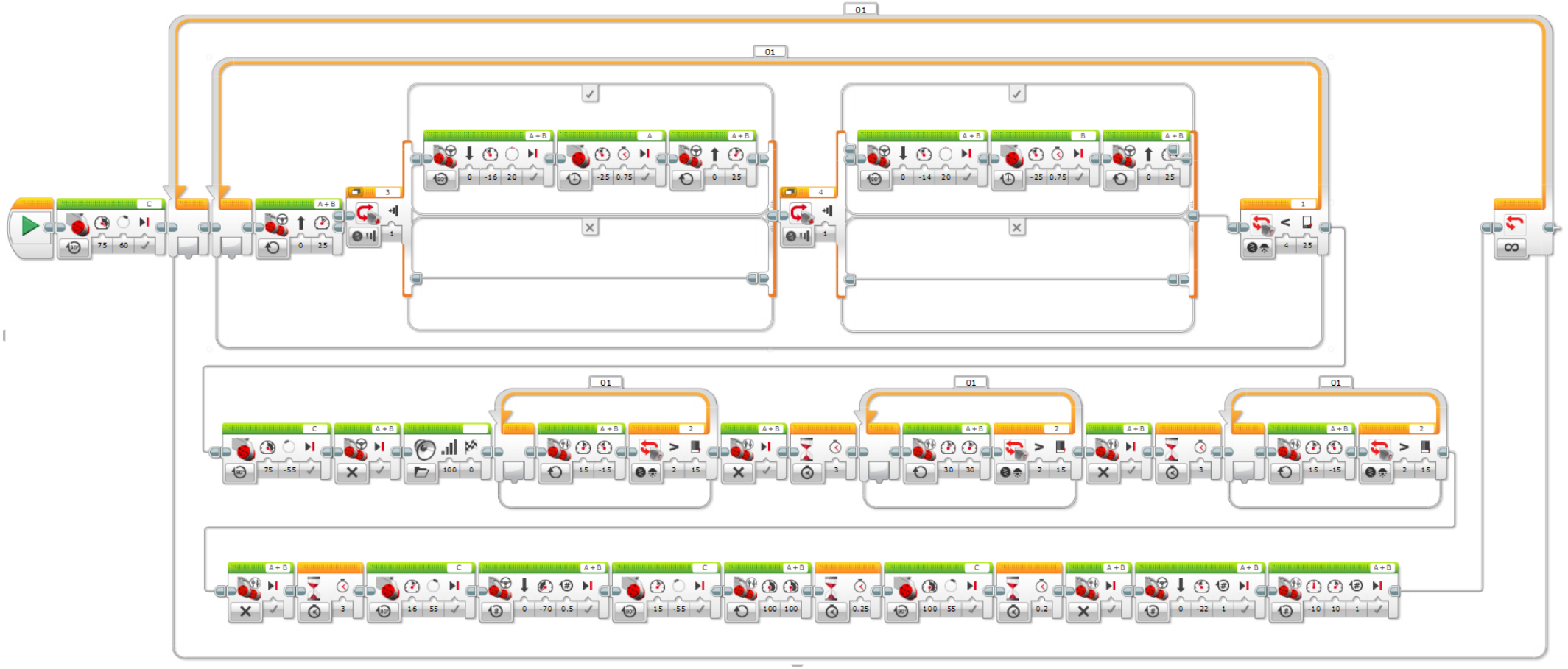


Figure 8 - code for Ball Finding and Goal Scoring (TASK 2)

There will be five balls placed randomly over the playing field. Robot is placed at the center of the playing and is facing the goal. When the robot is activated, first step is to lift the arm up. It is done by *move tank* block to the motor C. *Move tank* is used to move the robot forward unless until state of any of the bump sensors is change from 0 to 1 (either the one in the left or right). Two switch blocks are created of which one is associated with bump sensor which is in left to the robot and the other one is associated with the bump sensor which is in right to the robot. True condition of both the blocks is if the touch sensor state changes i.e. hit a wall, the robot will turn opposite side. False condition of the switch statements is if the light sensor detects any object (ball in our case), it will move towards the ball to grab it. *Move tank, two switch* statements consisting of touch sensor state changing are put inside a loop so that the robot will continuously traverse the playing field. This loop is terminated when the light sensor detects the ball. When the ball is detected, arms of the robot close and the ball held in the arms. Then the robot will stop moving and an audio is played to indicate the finding of the ball. Then the robot will start rotating in the same position where it stopped after grabbing the ball. It is put inside a loop so that the robot will keep turning until the loop terminates. Exit condition for the loop is detecting the light from the torch. When the loop terminates, or robot detect the light from the torch, it will stop and wait for three seconds. *Move tank* in *off* state is used to stop the robot and *timer* block is used to set waiting time. Now, another loop is created and *move* tank block is placed in it so that robot will start moving forward. This loop is terminated when the *light sensor* detects the light from the torch. When the light from the torch is detected, *move tank* in *off* state is used to stop the robot again and one more *timer* block is used to set a waiting time. By this time the robot will reach shoot position. Now, the robot will start rotating in the same position until it detects the light from the torch again. *Move tank* and *light sensor* blocks are used of *move tank* block is placed inside a loop and *light sensor* block is placed as the exit condition for the loop. *Move tank* in *off* state is used again to stop the robot from rotating and a *timer block* for three seconds is created. So, the robot will stop rotating and will stay idle for three seconds. Then the arms are lifted up and the robot is moved back. Now, arms of the robot are closed using *move tank* with motor C. Now, robot move forward and when it reaches the ball, it is shot by using arm. All blocks except first *move tank* which was used to lift up the arm of the robot are placed inside as there are five balls in the playing field and the robot must search all the balls and score goal.