ثانويـة التكنولوجيـا التطبيقيـة
Applied Technology High School

Robotics II

Module 6: Football Gen II (Robot Soccer)

PREPARED BY

Academic Services Unit

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Module Objectives

Upon successful completion of this module, students should be able to:

- Understand the rules of Football Gen II (Robot Soccer) Competition
- Assemble, program and test robots that are able to play soccer

Module Contents:

6.1 Introduction

GEN II was developed in 2007 for RoboCup Junior Australia competitions. It was created with ease of use in the classroom, accessibility to learners and challenging enough for experienced programmers, all in mind. This educational game has now been accepted as a pilot for World Robot Olympiad, and is officially called WRO GEN II Football.

Football Gen II Competition is a robot soccer match between two teams. Each team consists of two robots. The game will consist of two 10-minute halves. There will be a 5-minute break in between the halves. Robots should be constructed from LEGO MINDSTORM kits and controllers must be either RCX or NXT. Figure 6.1 shows an example robot soccer match at WRO 2011.

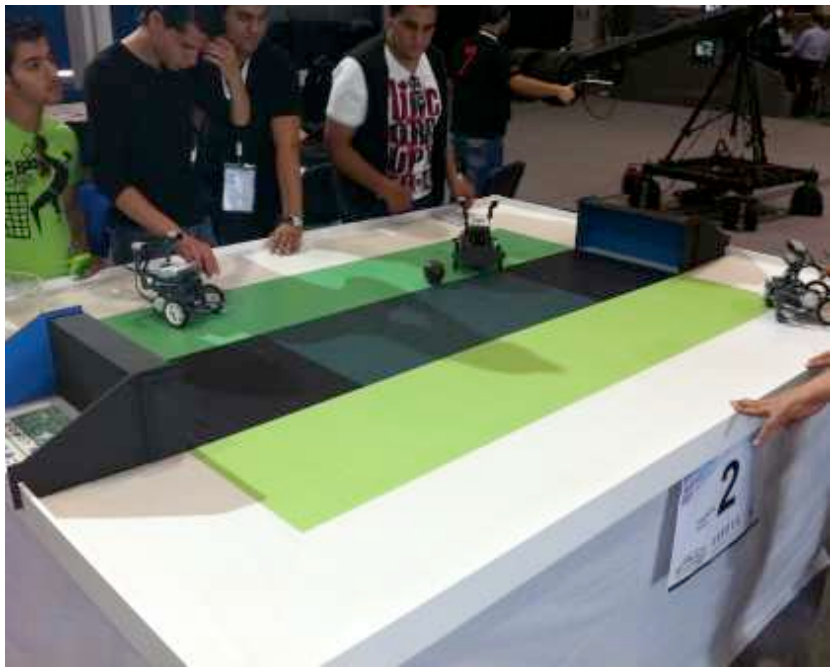


Figure 6.1: Football Gen II (Robot Soccer) Match

- **The GEN II Robot Soccer Field**

  The GEN II Soccer Field is a printed vinyl mat with a non-slip surface. Figure 6.2 shows the GEN II robot soccer field.

Figure 6.2 GEN II Robot Soccer Field

As shown in Figure 6.2, the green and black mat represents the playing field, with goals at each end. The playing area is 122 cm by 183 cm. The mat has a wide white border surrounding the playing field.

- **Robot Soccer Ball**

  The official ball for WRO GEN II Football is the HiTechnic IR Ball operated in MODE D (1200 Hz pulsed). The ball diameter is 7.5 cm. Figure 6.3 show the HiTechnic IR Ball.

Figure 6.3:HiTechnic IR Ball

- **Gen II Robot Soccer Main Rules**

  1. Robots will be measured in an upright position and with all parts fully extended.
  2. The upright robot must fit inside an upright 22cm diameter cylinder.

3. The robot height must be less than 22cm.
4. Robots must be controlled autonomously
5. Robots must be able to move in all directions
6. The use of remote control of any kind is not allowed
7. Blue tooth communication between robots is acceptable as long as it does not interfere with the performance of other robots.
8. Robots are to be constructed using strictly LEGO brand pieces, motors and sensors only. Other building materials **can't** be used, including glue, tape, screws etc.
9. If a goalkeeper is used, it cannot limit its movement to a single direction on the field. It must be programmed to move in all directions.
10. If a robot does not move and/or does not respond to the ball, it will be deemed damaged by the referee.
11. A damaged robot must remain off the field for at least one minute

In this module, you'll build, program and test robots that are able to play soccer according to Football Gen II Competition Rules

6.2 Lab Activity 1

Objective:

1. Build a soccer robot

Material per Group:

1. Lego Mindstorm NXT Kit
2. 1 compass sensor
3. 1 IR sensor

Background Information:

As per Football Gen II rules, a robot soccer player should fit inside a cylinder whose diameter is 22 cm. The height of the robot shouldn't exceed 22 cm. Robots will be measured with all moving parts fully extended.

The robot soccer will consists of the following hardware:

- NXT Brick/ RCX: the controller of the robot
- IR sensor: to detect the IR ball
- Compass sensor: determines the robot direction
- Light sensor: allows the robot to stay inside the field
- Ultrasonic sensor: allows the robot to check if the ball is close enough to be kicked.
- Two motors: to move the robot
- One motor: to kick the ball

In this activity, you will build a soccer robot according to the Gen II Football rules.

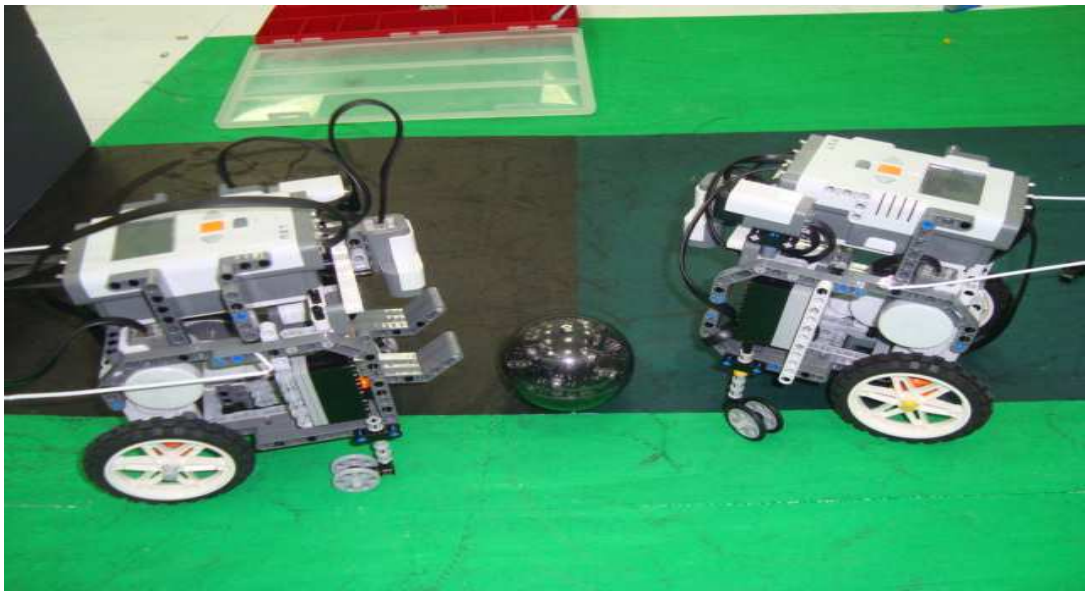
Procedure:

1. Build a robot soccer player according to the following rules:
   - Robot Size should fit inside a cylindar whose diameter is 22 cm.
   - Robot hieght: less than 22 cm.
   - The robot should have a light sensor to allow the robot to stay inside

the field

- The robot should have an IR sensor to track the IR ball.
- The IR seeker sensor operates best in a horizontal position.
- Mount the compass sensor at least 10 – 15 cm away from the NXT and NXT motors, as these tend to create their own magnetic fields which affect the readings of the compass sensor.

Here are some samples of robot soccer players:



6.4 Lab Activity 2

Objectives:

1. Program and test a robot soccer

Material per Group:

1. Robot soccer sample (build from lab activity 1)
2. USB Cable
3. Robot Soccer Mat

Procedure:

Task 1: Stay inside the soccer field.

To stay on the soccer field, your robot must avoid the soccer field's white borders.

1. Write an NXT-G program that will read the different colors of the robot soccer mat and display them on the NXT Screen.

Insert your program here:

2. Download and run your program

3. Place your soccer robot over each of the different colors of the robot soccer field. Record your findings on the below table:

Color	Reading

4. Write an NXT-G program that will make your robot soccer do the following:
    - The robot will move on the soccer mat continuously.
    - If the robot reaches the white borders, the robot will change its direction.

Insert your program here:

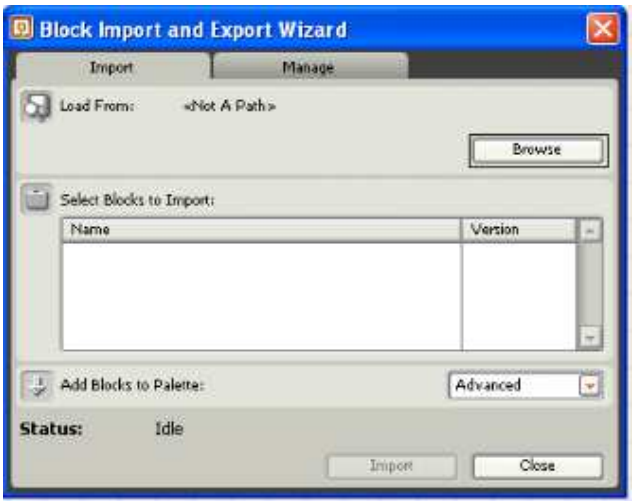
5. Download and run your program.
6. Place your robot on the soccer field. What happens when the robot reaches the white borders? _____

_____

Task 2: Follow the IR ball

When the IR sensor is mounted on a robot, the sensor will detect the direction of the soccer ball, and indicate that direction by a number. The direction numbers are as shown in the diagram below:

1. Download the IR seeker NXT-G block from the following link: http://www.hitechnic.com/file.php?f=270-IRSeekerV2.zip
2. Create a folder on your Desktop called "NXT-G Blocks".
3. For each .zip file that you download, expand and copy the folder that you find inside and place it in the "NXT-G Blocks" folder.
4. From the LEGO Mindstorms software, select the Block Import/Export Wizard from the Tools menu.



5. Click on Browse and then select the "NXT-G Blocks" folder on the Desktop.
6. In the listbox, select the blocks that you want to import.
7. Click Import
8. You will now find the sensor blocks that you imported on the Advanced Palette
9. Write an NXT-G program that will make your robot spin around until the sensor sees the soccer ball straight ahead (seeker direction number = 5). Once the ball is straight ahead, let your

robot go forward one rotation.

Insert your program here:

10. Download and run your program.
11. Place the IR ball around your robot.

Questions:

- Describe the robot movement when the IR ball is in front of the ball? _____

  _____
- Describe the robot movement when the IR ball isn't in front of the ball? _____

  _____

Task 3: Determine the opponent goal direction

To direct your robot toward the opponent's goal, you will use a compass sensor.

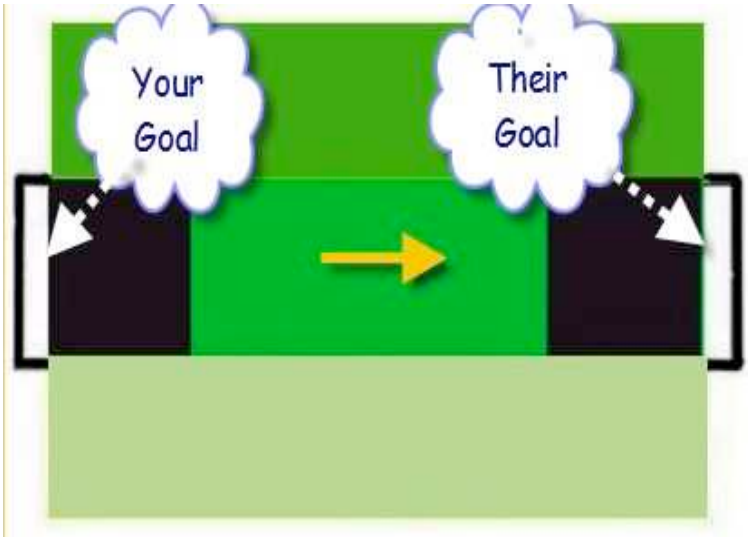
1. Download the compass NXT-G block from the following link: http://www.hitechnic.com/file.php?f=23-CompassSensorV2.1.zip
2. Import the compass block by following the same procedure for

importing the IR block.

3. Write an NXT-G program that will read the absolute heading of the compass sensor and display them on the NXT Screen.

Insert your program here:

4. Place your robot soccer in the center of the soccer mat, facing in the opponent's goal (see the yellow arrow below).



5. Download and run your program.
6. What is the compass direction that is displayed on the NXT screen?

   _____

7. Write an NXT-G program that will send the compass heading of our opponent's goal (obtained from the previous step) into your sensor (target heading). Then, use the compass sensor's "relative heading" output data wire to calculate a positive number if your robot has to turn to the left, or a negative number if your robot has

Insert your program here:

to turn to the right. Finally, use that positive or negative number to tell your robot to turn until it is facing in the direction of the opponent's goal.

8. Place your robot on the soccer field. Then, download and run your program. Does your robot turn toward the opponent goal? _____
9. Place another robot in front of your soccer robot. Does your robot still turn toward the opponent goal? _____

Task 4: Kick the ball

Before kicking the ball, you need to check if the ball is near your soccer robot kicking mechanism. You can achieve this using the ultrasonic sensor.

1. Write an NXT-G program that will read the ultrasonic sensor and display the readings on the NXT Screen.

Insert your program here:

2. Download and run your program.
3. What is the best distance between your robot soccer and the ball for a good kick? _____
4. Write an NXT-G program that will allow your robot soccer to kick the ball when the distance between the robot and the ball is suitable. (Note: your code will depend on your kicking mechanism)

Insert your program here:

Task 5: Final Code

1. Based on the previous tasks and your strategy in playing the soccer game. Write an NXT-G program that will combine the previous codes into one program that will allow your robot to play an effective soccer game.

Insert your code here:

2. Switch on the IR ball. Then, place the robot on the soccer field.
3. Download and run your program.

Questions:

- Does your robot stay inside the soccer field? _____
- Does the robot follow the ball? _____
- Does the robot kick the ball when it directs toward the opponent goal? _____
- Does your kicking mechanism work appropriately? _____
- Compete with other groups and enjoy the game.

References:

- http://www.wro2012.org/
- http://www.hitechnic.com/downloadnew.php?category=13