GEN II Robot Soccer
EV3 Compass
Training Curriculum

Brian Thomas

modern teaching aids

Energizer
Overview
Welcome! The aim of this curriculum is to guide you through a sequence of programming steps in order to allow a robot to compete in RoboCup Junior and WRO. Every attempt has been made to keep these steps simple and easy to attain. Consequently, modifications may be needed to program a more efficient robot for the competitions.

You will find that GEN II is no harder than any other forms of Robot Soccer or other robot competitions. It is actually easier for beginners to enter and compete successfully in Soccer! They can then raise their expectations and skills as they progress. The GEN II field just adds a further dimension of control for the robots and programmers when they get to that stage. In short, it allows for advanced robots to have more control over where they are on the GEN II field.

An added advantage is that the GEN II mat is very classroom friendly, you just have to roll it out and then start playing.

The sequence of this Curriculum starts with programming for a Simple Simon Soccer Playing Robot. These instructions can be found at http://www.robocupjunior.org.au/tutorials. This will allow any robot to successfully play soccer on any field type. The controlling aspect of any robot soccer game is the ball. If the ball is on the field then so should the robots be, chasing it.

It is important that students work through this curriculum sequentially. They need to understand the differences that may be required for their individual robots. Students have often gone straight to the more complex programming, become lost and then disillusioned. Students who work through the curriculum enjoy the success at each step, and carry with them knowledge that will eventually allow them to develop their own algorithms programs.

Very few students complete this curriculum in a single year’s preparation. They set their goals at a certain level and return the following year with their goal being the next level. This is usually with a different robot, so they need to reprogram anyway.

This curriculum essentially deals with programming the striker robot. If you wish to have a goalie, the programming for a goalie is very easy after mastering the striker. You use the same principles, but limit the robots movement and for every forward command, have a reverse.


Add an infra red sensor and a bull bar and you are ready to go
Further information can be obtained from our web site www.robocupjunior.org.au.

NOTE ******

These notes use the Tris10 Findball IR sensor.

If you are using a Hitechnic IRV2 sensor, it is easy to substitute the Hitechnic IRV2 block for the Ultrasonic Sensor block when you see it or Vice Versa.

Any questions queries or comments, contact: b.thomas@ccq.vic.edu.au

Please Note
These training notes are the property of RoboCup Junior Australia Inc. All or part of these notes are not to be copied or used for commercial gain without the permission of the RoboCup Junior Australia Inc Committee.

**LEGO, Mindstorms and EV3 are Registered Trademarks of the LEGO Corporation**
**Compass 1: Ball Avoidance**

**Overview**

You are now able to look for the ball and kick it. The only thing left is to make sure that you will kick it in the right direction. Therefore you must use your gyro sensor to make sure you are kicking in the right direction and not goals for the opposition.

Before using the gyro sensor, you must devise tactics to avoid the ball when it is detected, but the robot is heading in the wrong direction.

The diagram above shows the desired path when the robot is kicking from right to left and is stuck on the wrong side of the ball. The robot must trace a path that takes it past the ball and quickly begin a scan that will have it approaching the ball from the right direction.

1. The robot senses the ball.
2. The robot checks its compass to see if it is kicking the right direction.
3. It finds it is on the wrong side of the ball.
4. The robot turns 90 degrees right.
5. The robot traces a circle approximately 50 cm in diameter.
6. The robot makes a short reverse to free it, if it has become stuck. **Important!**

This is not easy, as the path varies from robot to robot and changes as battery levels change.
**Method**

Start with a new program

- A sample program can be seen below.

- It is good for the robot to play a sound so that you know it is in ball avoid mode.
- Start with the robot turning right for .3 sec at full power
- Then veer left for about 2 sec
- A quick reverse for .3 sec to free it if it is stuck.

Load this program and repeatedly test it with the ball (turned off) starting at different distances between 20cm and 70cm from the ball.

Experiment by changing the different times that the robot is supposed to turn and circle the ball

The robot should just go past the ball without touching it and finish behind the ball.

*It takes time to perfect this, but it is important to persevere with it.*
Programming for the Compass Sensor: Student’s Notes

Overview
This unit introduces a compass switch that will allow the robot to chase the ball if it is facing in the correct direction and use ball avoid if it is facing the opponents goal. This will allow your robot to be very competitive at the top level of RoboCup Junior.

Using the Compass Sensor
Make sure that you read all instructions before using the Hitechnic Compass Sensor. You will need to check whether you have the Hitechnic Compass sensor installed on your software. Click on the Yellow “Sensor” tab in the main EV3 program. The compass sensor icon should be at the right hand end of the palette.

You may need to download the compass sensor icon from the Hitechnic web site. http://www.hitechnic.com/downloadnew.php?category=38

Follow all instructions closely and you should be able to find the new Compass Sensor Icon in your Yellow Palette now.

Robot Setup
The compass sensor can be plugged into sensor port 2 of the EV3. The ball sensor should be plugged into Sensor Port 1. The down light sensor should be plugged into Sensor Port 3. The down sensor is required to detect colours on the GEN II field. Students have found it is advantageous to have a means of manually zeroing the compass on the robot. They use a turntable that can be locked with a gear.
A programming method of zeroing the compass is covered in a later unit in these notes.

Remember to locate your compass as far away from motors and motor wires as possible, as these tend to create their own magnetic fields.

The easiest way to zero your compass sensor is to:

- Go back to the main menu on the EV3. Click across to the control section of the EV3. You will find that Port View is the first option in this section. Click on this.
- Scroll across to Port 2. It should show the message 2: HT-CMP-DEG
- The reading will change from 0-360 as you rotate the robot.

Hint: if you cannot get a change in readings when the compass is rotated, just unplug and reinsert the compass lead.

- Start with your robot facing the direction that you want to kick.
- Turn the robot clockwise to face right angles to the goal.
- Rotate your compass on the robot until it is reading 0 degrees.
- You will now find that with your Compass Sensor icon, less than 180 degrees is the wrong direction. Greater than 180 degrees will be facing your goal.
**Method**

This unit will incorporate a Compass Sensor Switch with the Ball Avoid Block from the previous unit, and added to a Simple Soccer Player Program. This program, if run properly will allow you to be very competitive in RoboCup Junior or WRO competitions.

**Programming**

- Program an Unlimited Loop along with a Switch inside of the loop.
- Set the switch to Logic.
- Insert the Compass sensor tile before the switch and set this to Measure-Absolute Heading and Sensor Port 2.
- Add a Compare Tile and set this to a Greater than 180.
- Wire these up to the Switch as shown.
- For the True Branch of the switch, put a forward for 1 second Motor tile in. this is the correct direction so the robot should chase the ball.
- For the False section, which occurs when the ball is in the wrong direction, copy and paste the Ball Avoid commands from the previous unit. Your times should be different to the ones shown.

Test this program extensively by placing the ball 20cm in front of you robot, in different directions, to make sure that it is working perfectly before putting it into the Simple Simon Program.
Create a Simple Soccer Player program from earlier units.

Make sure this is in tabbed view.

Check that he robot should be able to scan and chase the ball consistently.

The only time you can check the compass is when the ball is in front of the robot. This is when the IRV2 reading is 4, 5 or 6, or the Tris10 sensor is reading 3. These are the tabs where the robot is going straight ahead to chase the ball.

Now simply copy and paste the Compass Switch into these tabs, without the loop, replacing the command where the robot is being told to go straight forward.

Notes

- The ball avoidance will have to be varied for different robots so that they most efficiently avoid the ball.
- You may have to slow down the turning speeds as the compass may need time to catch up.
- Keep working with this program until you can recognise what the robot is doing in each part and you have it working perfectly.
**Super Soccer Player**

**Overview**
You will by now have noticed that after the ball avoid, the robot rarely lines up directly in line with the goal. Goals are missed even though the robot has detected the ball directly in front of the goals.
This program will tell the robot to continue to avoid the ball until it is directly in line with the goals.
Similar to high performance cars, this is a high performance program is more susceptible to things going wrong. It is recommended that all of the simpler programs are mastered before attempting this program. The operator need to have solid experience beforehand to recognise problems and to trouble shoot them.

**Method**
In the previous unit, the robot circles the ball for a set amount of time. Even though the robot will not kick own goals, there is no guarantee that it will finish in line with the goal it is kicking towards. If you can successfully refine the following program, you will find that the robot will definitely line up with the goals and score more often.

**Robot Set-up**
IR V2 sensor(ball) Port 1
Compass Sensor Port 2

**Programming**
- Start with the test program used to ball avoid in the previous unit.
- Place a loop over the tile where the robot is circling the ball.
- Set the loop to logic and Loop Until True.
- Add another Compass Sensor Tile.
- Add a compare tile.
- Set it to greater than 170 degrees.
It is important that the robot does the ball avoid in a clockwise direction. If it does not do this, just reverse the direction of each of the motor controls.

Test and retest this program to get it working perfectly. This should correspond to when the robot stops circling when it is facing directly across the field. This is also when the ball is also directly in line with the goal. The robot should then kick the ball into the goals.

Now copy and paste this into the 4, 5 and 6 tabs of the Hitechnic Sensor program or 3 tab of the Tris10 program.

Extensions

Zero your compass with the robot only aiming at 60 degrees to the right of the goals. That way your robot will be aiming more accurately at the goals.

In this situation the first compass reading should now be Greater Than 240 degrees and when the robot is circling the ball it should stop at Greater Than 210 degrees.

To really finess your robot's performance program it to circle right or circle left around the ball depending on which will be the shortest route. The new switch for this should be set at Greater Than the compass reading when the robot is facing directly at the opposition's goals. In this case it is at 120 degrees. Not easy, but it will make you competitive in any competition.

If you find that the robot is stuck in a loop where it is turning backwards and forwards when it ball avoid, this occurs when the initial turn is through the 0-360 point. A timed turn back through this point, inserted before the loop will get the Ball Avoid working again.
Have you found that the robot is detecting the ball and starting its ball avoid from too far away. Consequently it completes the ball avoid and it still has the ball in the direction of the opponent’s goal. This means it has to repeat the whole Ball Avoid process again.

You want your robot to start its ball avoid at the same distance from the ball.

Test the following program using the Hitechnic Sensor Enhanced mode.

- Adjust the “b” value until the robot consistently stops 15-20cm from the ball.
- Copy and paste the contents of the loop into the compass check tab (3 for Ttris10 or 4,5,6 for IRV2) of your Super Soccer Program
- Now replace the Motor stop icon with the entire previous contents of the tab.

Not easy, but worth doing.
Automatic Compass Calibration

Overview
You have previously used a manual method to zero the compass. You can now permanently attach your compass to a place above the EV3. This unit will allow the robot to set the compass in the correct direction at the start of each game.

Method
The compass reading will be taken when the program is started. The robot just needs to be facing the direction that you wish to zero to. From here that amount will be subtracted from any reading that the compass takes. Of course there is a problem with the 0/360 spot on the compass. This is rectified by adding 360 when the calculation is less than zero.

To start the robot playing Soccer, the touch sensor just needs to be pushed. This also serves the purpose of starting the robot immediately, without the lag associated with starting the EV3. You will find that this is a huge advantage in the game situation.

Robot Set-up
IR V2 sensor(ball) Port 1
Compass Sensor Port 2
Touch Sensor Port 3

Programming
An enlarged version of this program can be found on the next page.

- The first compass reading is saved in the variable “suitcase”
- This is set to “Write”.
- Click on the Variable Name Box.
- Click on Add variable.
- Call this variable Comp
- Start an Unlimited Loop.
- Take another compass reading and subtract the Variable “Comp” from this value to zero it.
- You must set the Variable “Comp” to “Write” to use it.
- The new Variable is set to “Read” and named CompZ.
- Now you must check that this reading is a positive value.
- If it is Greater Than Zero on the switch, it is not changed, but just called CompR.
- If it is less than Zero, 360 is added to it and the resulting variable is called CompR.
- CompR is then displayed on the screen, just to make sure that it is all working OK.
- Set the Display Icon to “Wired” by clicking on the box at the top right hand corner of the tile.
- Now select text in the bottom left hand corner of the tile.
- You can now adjust the position and style of the display with the other settings.
• Now, open up your working Soccer Player program.
• Copy and Paste the first two Read and Write tiles to the front of the Soccer Player program.
• Insert a Wait For Touch Sensor Pressed tile before the loop.

• Copy the following section from the Compass Zero program.

• Paste the Compass Zero section just before the first light reading of the Soccer Player Program. This will take a few attempts as the EV3 program does not like it.
Replace each compass reading tile in the program following this, with the CompR variable, set to Read.

Now you just need to aim your robot towards the zero position each time you start playing.

Done!!!