ZERO ROBOTICS

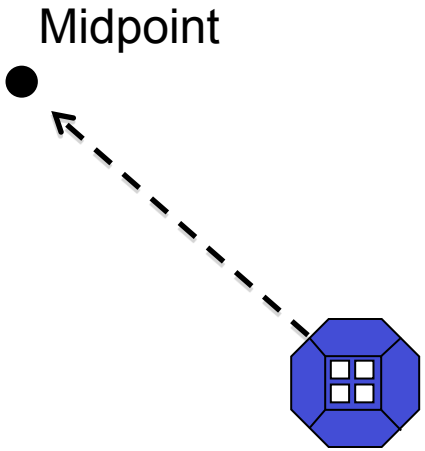
ISS PROGRAMING CHALLENGE

For Loops

Goals

In this tutorial you will:

- Use a **for loop** to repeat an action a set number of times
- Find the position of the other satellite
- Program your satellite to move toward the other satellite, but stop halfway



Create a new project

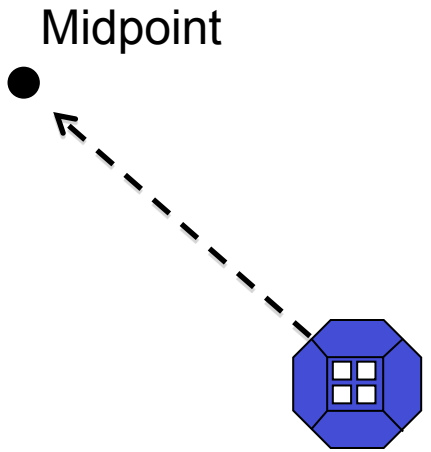
- Create a new project
- Name it “Project8” and choose “FreeMode” and “Text Editor”
- Create the following variables and arrays:
  - **`int counter`**
    - Set initial value to 0
  - **`float my_state[12]`**
  - **`float other_state[12]`**
  - **`float target[3]`**

do not set initial values

Program outline

In this tutorial, you will move your blue satellite half the distance toward the red satellite.

- First, you will use two API functions, **`getMyZRState`** and **`getOtherZRState`**, to find the starting positions of the two satellites.
- You will find the coordinates of the midpoint between the satellites.
- You will move to that position using **`setPositionTarget`**.



`getMyZRState` and `getOtherZRState`

- **`getMyZRState`** finds the position of your satellite (blue) and writes it to an array.
- The array must consist of 12 floats. The first three members (index numbers 0 to 2) contain the x, y, and z coordinates of your current position.
- The other numbers in the 12-member array contain other information about your current state (for example, your current velocity) that you will not use in this tutorial.
- **`getOtherZRState`** does the same thing, but it sets the array to the state of the other satellite (red.)

```
void loop(){
  //This function is called once per second.
  //Use it to control the satellite.

  api.getMyZRState(xxx)

  api.getOtherZRState(xxx)


}
```

Array members:

xxx[0] : x coordinate
xxx[1] : y coordinate
xxx[2] : z coordinate
xxx[3] to xxx[11]: other things

Set up counter

- Go to void loop() section and create an if-then statement using the condition that the counter is set to zero ("counter == 0").
- Putting the calculations in this statement means they will happen only once, at the start when **counter** is 0. Otherwise your target will keep changing as your position changes.
- Finally, increment counter. Add **counter++;** after the if statement as you have done previously.

```
void loop(){
  //This function is cal
  //Use it to control the
  if (counter == 0 ){
  }
  counter++;
            }
```

Set *my_state* and *other_state*

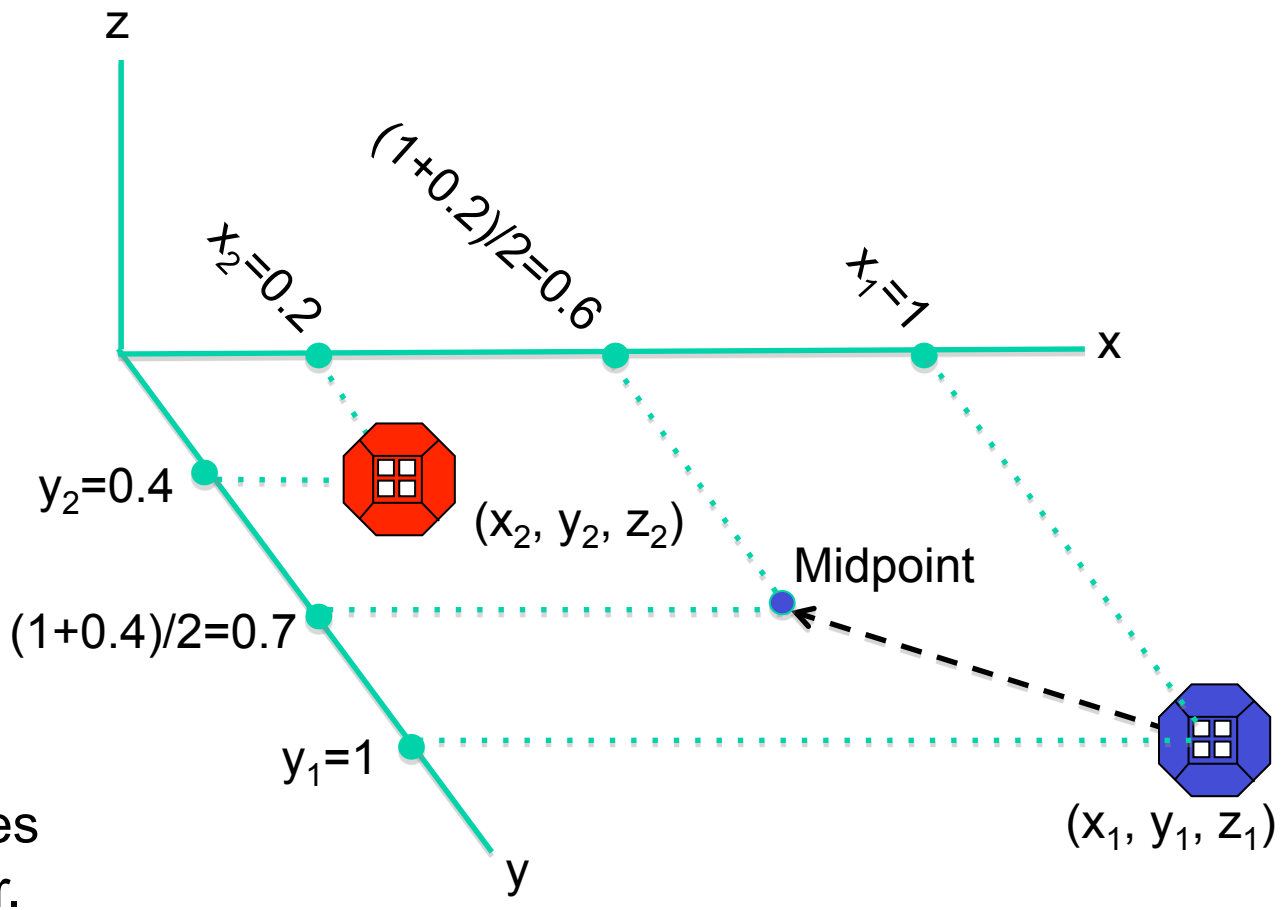
- Now you will find the positions of the two satellites so you can calculate your target.
- In the if-then statement, call the api functions **getMyZRState** and **getOtherZRState**, and write this information to the previously created arrays **my_state** and **other_state** respectively.
- The arrays **`my_state`** and **`other_state`** have now been set to the states of the two satellites.

```
void loop(){
  //This function is called once per se
  //Use it to control the satellite.
  if (counter == 0 ){
     api.getMyZRState(my_state);
     api.getOtherZRState(other_state);
  }
    counter++;
          }
```

Calculating the target coordinates

- The target is the midpoint between the two spheres.
- We can find the coordinates of the midpoint by taking the average of each coordinate as shown.
- For example, the x coordinate is

  $(x_1 + x_2) / 2$
- Using a **for loop** makes this calculation simpler.



Using for loops

- The for loop has 3 statements:

  The first is the starting index, the second is the condition for termination of the loop, and the last is how the loop will be incremented. **(index1 = x; index1 <= y; index1++){ }**

- The index variable is a variable to keep track of the for loop, and will need to be initiated within void loop ().
- To create a for loop for calculating the target array:
  - –Declare the variable **int index1** in void loop above the if statement.
    - Unlike the *global* variables declared above void init(), variables declared inside the loop are *local*; they will be "destroyed" when the loop ends and will not retain their values when the loop is called again a second later.
  - –After **api.getOtherZRState(other_state);** enter the for loop
    - Set the starting index to 0 **index1=0**
    - Set ending condition to be **index1 <= 2**
    - The index will be incremented by 1 after each iteration, so set the last argument of the for loop to **index1++**.
    - The target calculation will be added between the brackets.
- The code inside the loop will be executed until the termination condition is false.
  - In this case, it will execute 3 times as index1 goes from 0 to 2.

Using for loops (cont.)


```
void loop(){
  //This function is called once per second.
  //Use it to control the satellite.
  int index1;

  if (counter == 0 ){
     api.getMyZRState(my_state);
     api.getOtherZRState(other_state);
    for (index1 = 0; index1 <= 2; index1++){
    }
  }
    counter++;
          }
```

Syntax

- Instead of declaring the index variable outside of the for loop in a separate line, you can declare it and assign it an initial value inside the for loop like this:

```
for (int index1 = 0; index1 <= 2; index1++){
```

- Either format is acceptable. As the tutorials become more advanced, we will switch to the format above because it is more compact. However, you are free to use either format.

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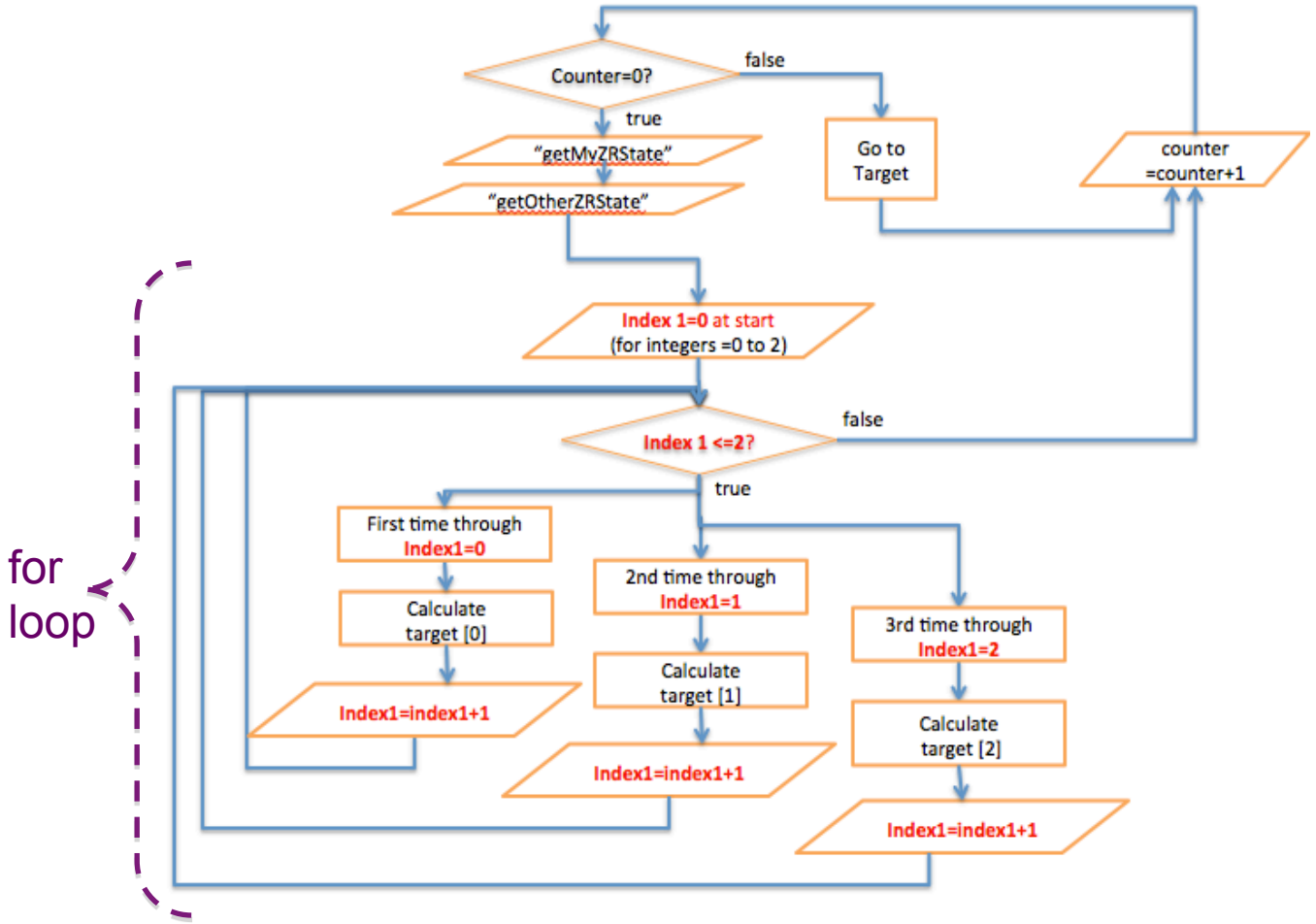
For loop flowchart

- The **for loop** is a loop inside the main SPHERES loop as shown in the flowchart
- The variable **`index1`** is highlighted
- Do you see that the **for loop** in this example executes three times inside the main loop?



target[0] = x coordinate
target[1] = y coordinate
target[2] = z coordinate

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Calculating target position

- The next step is to add the calculation for the target position between the brackets in the for loop.
- Write an equation to set the **target** array to the midpoint between the two satellites at their starting position, as shown.
- Recall that to find the midpoint, you must find the average of two points.
- Because **`index1`** goes from 0 to 2, the first time the loop will set **`target[0]`** (the x coordinate), then **`target[1]`** (y), then **`target[2]`** (z.)

```
void loop(){
  //This function is call one per second. Use it to control the sa
  //Use it to control the satellite.
  int index1;

  if (counter == 0 ){
     api.getMyZRState(my_state);
     api.getOtherZRState(other_state);
  }
    for (index1 = 0; index1 <= 2; index1++){
      (target[index1])=(my_state[index1] + other_state[index1])/2;
    }
    counter++;
}
```

Calculating target position (cont.)

- Do you see how this line of code sets each coordinate of *target* to the average of **`my_state`** and **`other_state`**?
- Finally, outside the if statement at the very end of the loop, add **`setPositionTarget(target)`**.

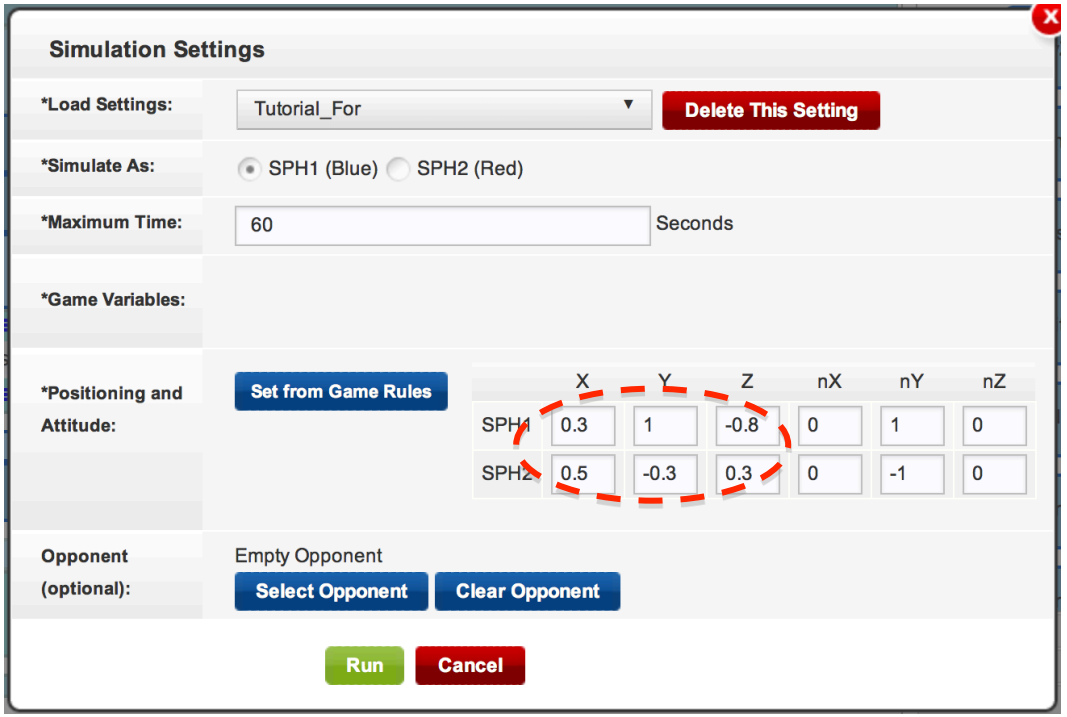
```
void loop(){
  //This function is call one per second. Use it to control the sa
  //Use it to control the satellite.
  int index1;

  if (counter == 0 ){
     api.getMyZRState(my_state);
     api.getOtherZRState(other_state);
  }
    for (index1 = 0; index1 <= 2; index1++){
      (target[index1])=(my_state[index1] + other_state[index1])/2;
    }
    counter++;
     api.setPositionTarget(target);
            }
```

WARNING!

- You must always be careful when using **for loops** to set arrays.
- For example, if you change the ending condition statement in the **for loop** from 2 to 3, the program will try to set **`target[3]`** to a value.
- But **`target[3]`** does not exist.
- This can cause serious problems. A large number of real-world computer crashes are caused by this type of mistake.
- *Make sure you are only putting values into array members that actually exist!*

Simulation

- Compile
- Simulate
- Create new setting “Tutorial_For”
  - Set Maximum Time to 60 seconds
  - Set the starting coordinates of SPH1 to x = 0.3, y = 1, z = -0.8
  - Set the starting coordinates of SPH2 to x = 0.5, y = -0.3, z = 0.3
- Run
- View simulation
- Change the starting coordinates to your own values and try it again.



Review

Congratulations!

- You have found the positions of the satellites in your code.
- You have used a **for loop** to carry out repeated calculations.
- You have programmed one satellite to move halfway toward the other one.