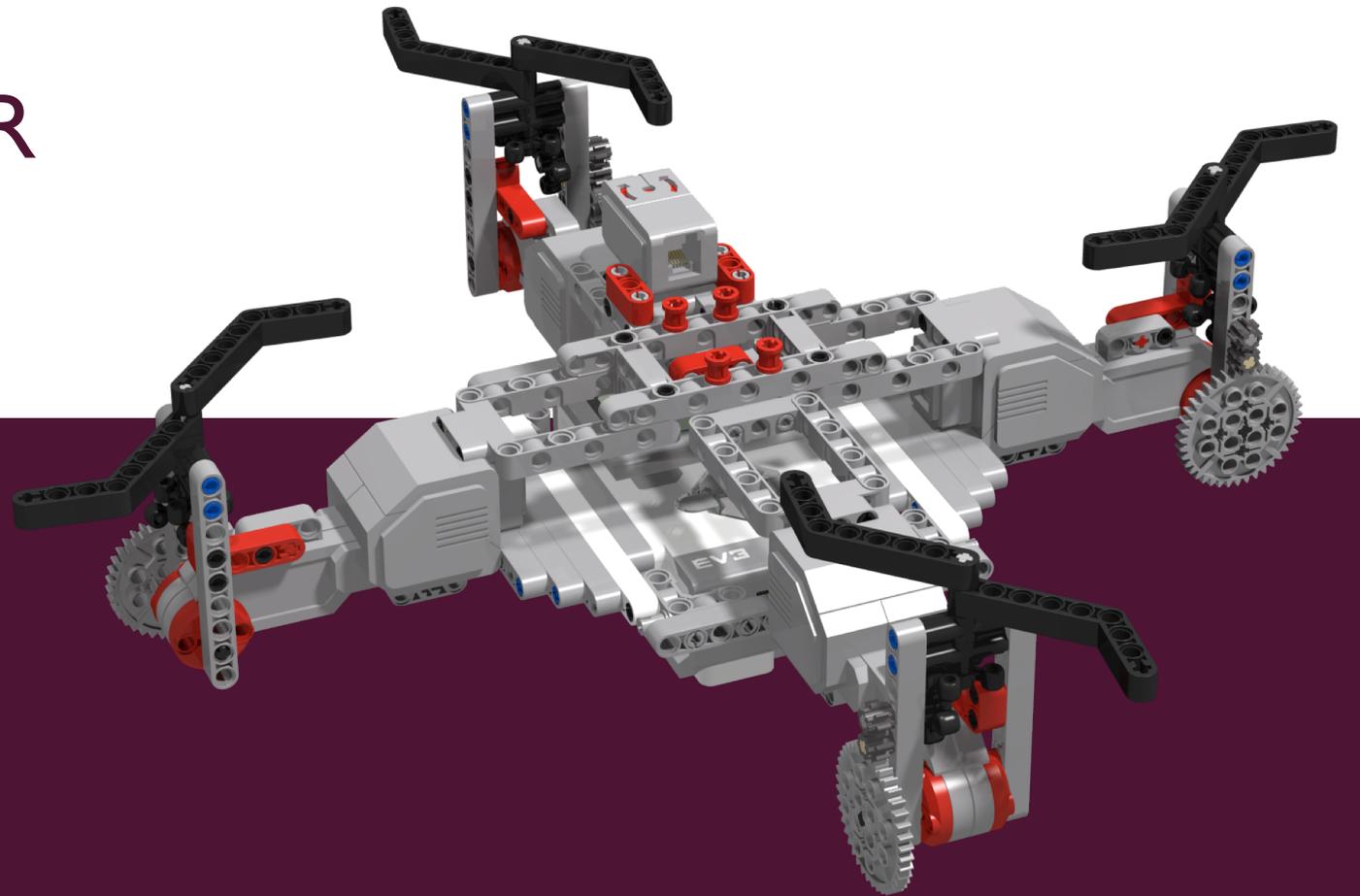# CONTROLLING YOUR QUADCOPTER

BY SANJAY AND ARVIND SESHAN

OBJECTIVES

- In this lesson you will learn about the different movements a quadcopter can make and how they are controlled using a remote control

- You will build your own remote control for your MINDSTORMS Quadcopter

- You will learn how to use Bluetooth to create the remote control for your MINDSTORMS Quadcopter

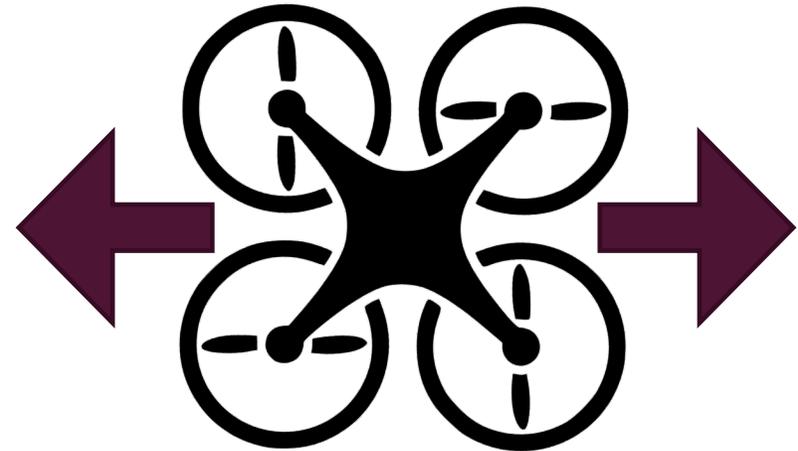# WHAT IS YAW, PITCH AND ROLL?

- Yaw is moving the head of the quadcopter either to right or left,
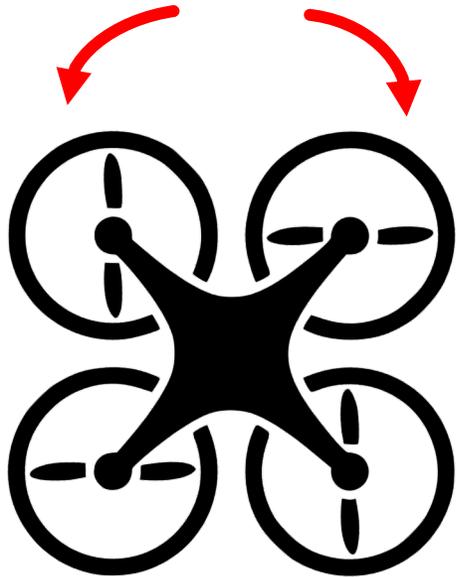
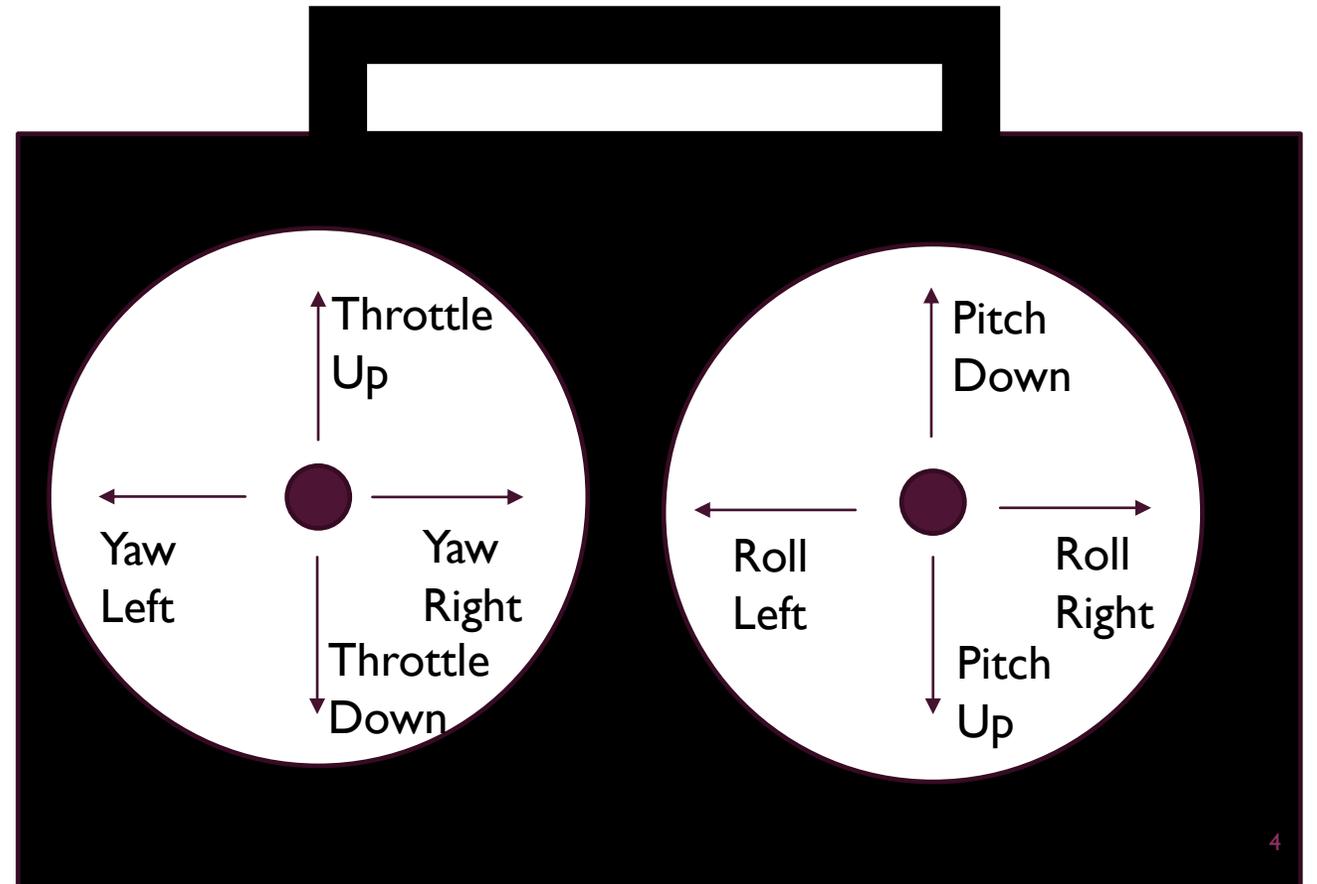- Pitch is moving either forward and backward.
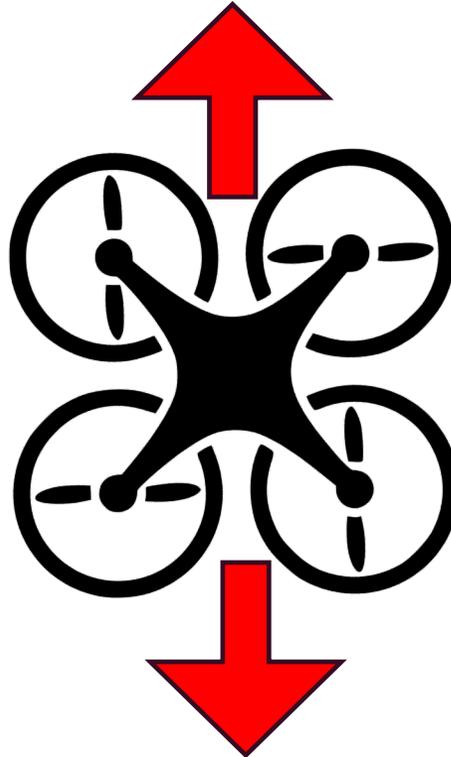
- Roll is making the quadcopter fly sidewards, either to left or right.

MAPPING ON TO YOUR CONTROLLER

- This is how the movement would map on to a traditional controller

Throttle Up

Yaw Left

Yaw Right

Throttle Down

Pitch Down

Roll Left

Roll Right

Pitch Up

BUILDING THE EV3 REMOTE CONTROL

- Follow the build instructions and construct the controller
- Connect the cables as indicated in the image on the right
- Note that the controller is not designed to be exactly the same as a real Quadcopter controller
- Your EV3 Quadcopter will not fly/behave in the same way as a real one
- The goal is to show you one way in which devices can communicate similar to a remote control and a quadcopter.
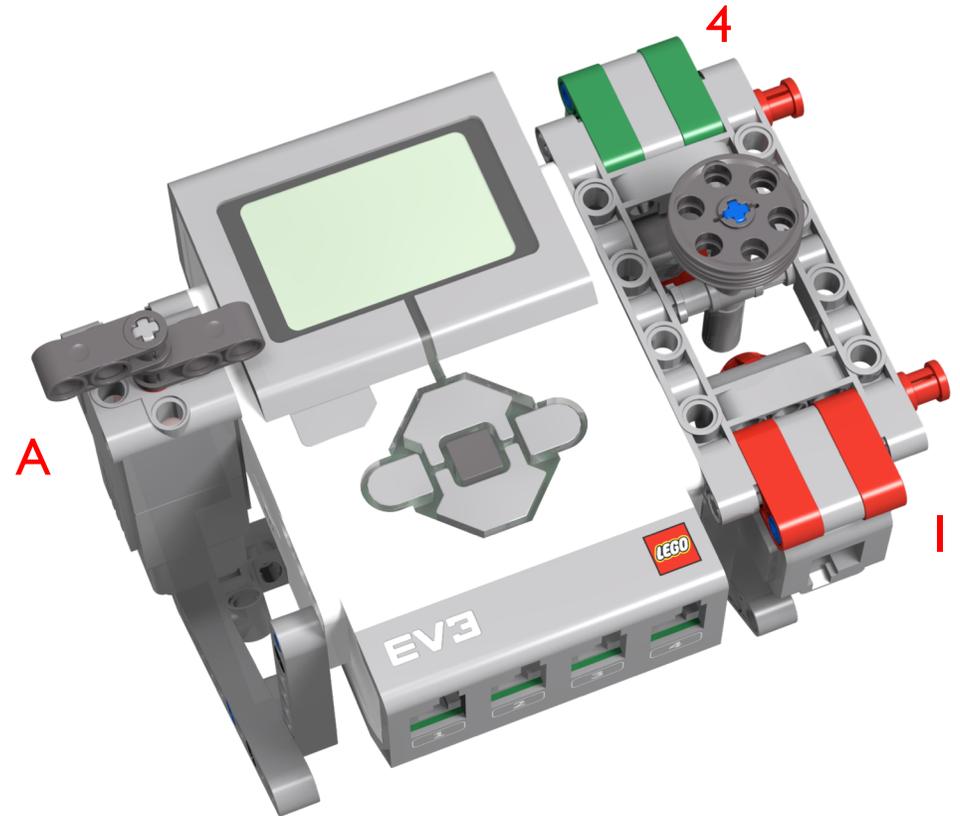
HOW DOES THE REMOTE COMMUNICATE WITH THE QUADCOPTER?

- The EV3 also uses a Bluetooth link to connect to other EV3s

- What is Bluetooth?

  - Bluetooth uses radio frequencies to communicate between devices

  - The EV3 also uses Bluetooth to download programs wirelessly

EV3 BLOCKS YOU WILL USE

- Messaging block in Send Mode and Receive Mode

- Bluetooth Connection Block in Initiate Mode

- You will also use loops, switches, math blocks, compare blocks, variables, constants, data wires, and unregulated motor blocks.
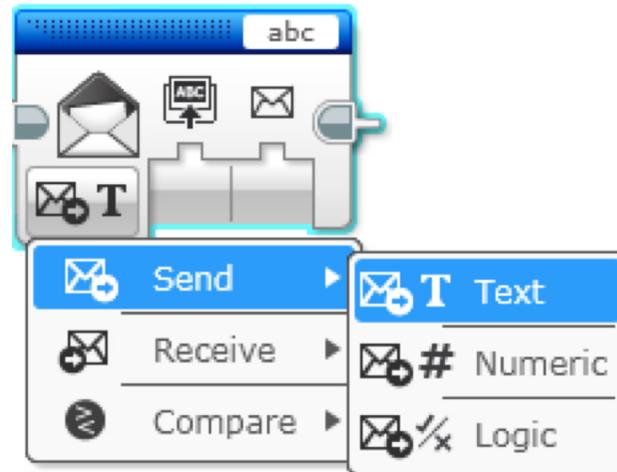
STEP 1: NAMING THE BRICKS

- Give each brick an unique name (in this exercise use "Quadcopter" and "Controller")

  - If you are doing this in a large group or classroom, add a group number to each brick name (e.g. Quadcopter2 and Controller2 for group 2). This will avoid confusion when different groups are

- Use an USB cable for downloading code to the bricks (rather than Bluetooth). You cannot connect the EV3s to each other and download using Bluetooth from a PC at the same time

STEP 2: ACTIVATE BLUETOOTH ON THE EV3

- Turning on Bluetooth:
  - On the Controller EV3 menu, go to the symbol that looks like a wrench
  - Go down to the word "Bluetooth" and activate it
- To connect to another brick go back into the Bluetooth menu
  - Go to "Connections"
  - Select "Search" and find the other brick's name (Quadcopter)
- You can also manage your connections with the Bluetooth Connection Block. But we do not use this block in this lesson.

STEP 3: CHALLENGE 1

- Objective: Send messages from the Controller to the Quadcopter

  - You will send a Hello Message from the Controller EV3 to the Quadcopter EV3 each time you press a brick button

- Key steps:

  1. On the Controller, have a loop that waits for button press and then sends a message using Bluetooth

  2. On the Quadcopter, connect to the Controller first. Then, loop waiting for a message. When you receive a message perform an action to show that you have received it.
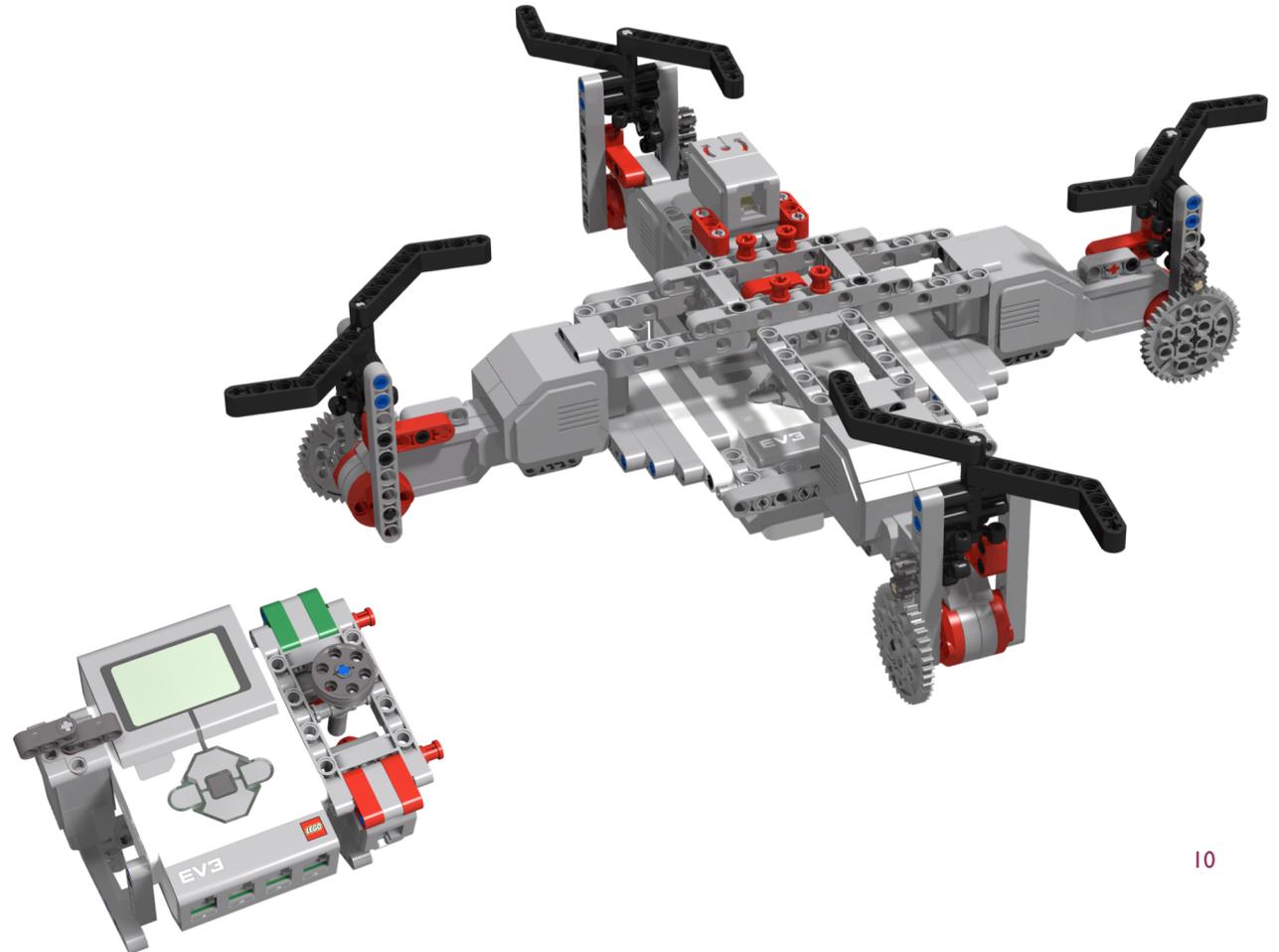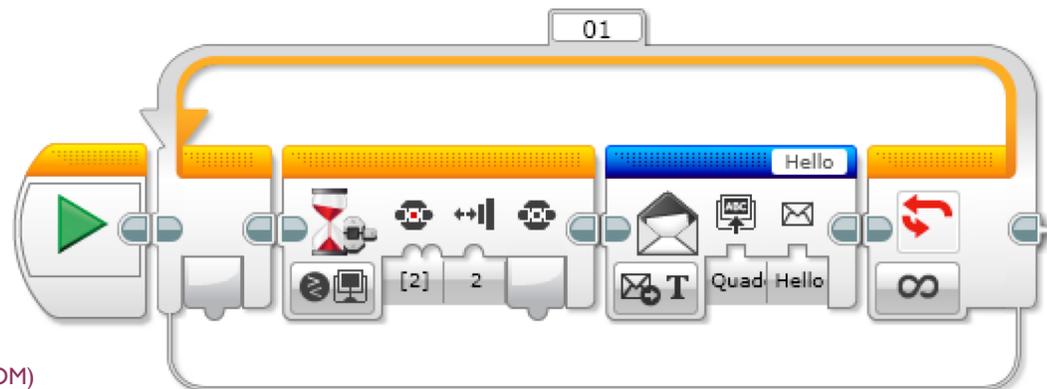
CHALLENGE SOLUTION

Quadcopter
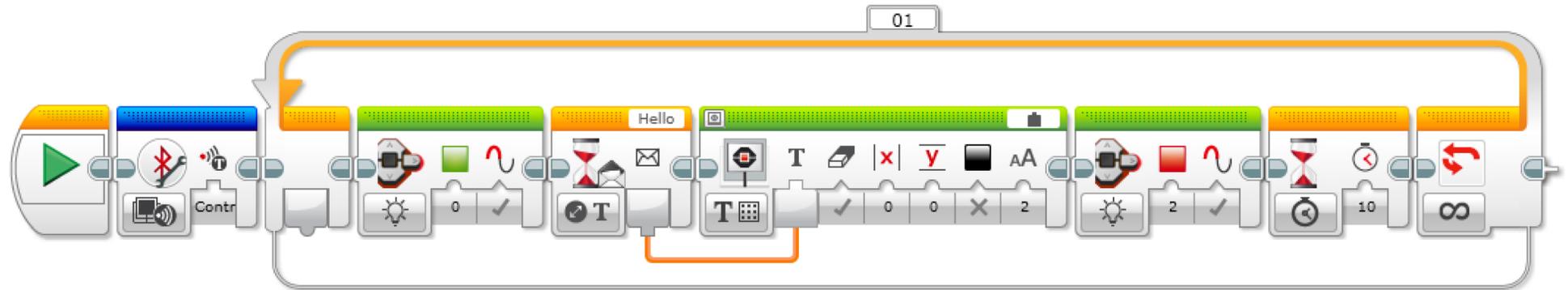
In the Quadcopter code, the brick color also changes to indicate that it has received a message

Controller

CHALLENGE 2

- You will program the left toggle to turn the blades left or right depending on the direction of the toggle

- You will program the right joystick to increase and decrease the power of the motors

- You will program the center button to enable and disable counter rotation

CHALLENGE 2 – SETUP

1. Create two programs

2. Name the programs Controller and Quadcopter

We will start with the Quadcopter code since it is simpler. The key steps are:

1. Start a Bluetooth connection

2. Loop waiting for messages from the controller

3. The controller messages should provide power levels for each of the quadcopter motors

CHALLENGE 2 – QUADCOPTER PSEUDOCODE

1. Open the program called "Quadcopter"

2. Add a Bluetooth Connection Block in Initiate mode and set the parameter to connect to "Controller". This will make sure that the two robots are connected

   ■ Change "Controller" to whatever name you used for the controller's brick

3. Add a loop

4. Add a Messaging Block in Receive – Numeric mode and set the message title to "PowerA"

5. Add an Unregulated Motor Block set to Port A and drag the data wire from the Messaging Block into the power input of the Unregulated Motor Block

6. Repeat steps 4 and 5 for motors B, C, and D
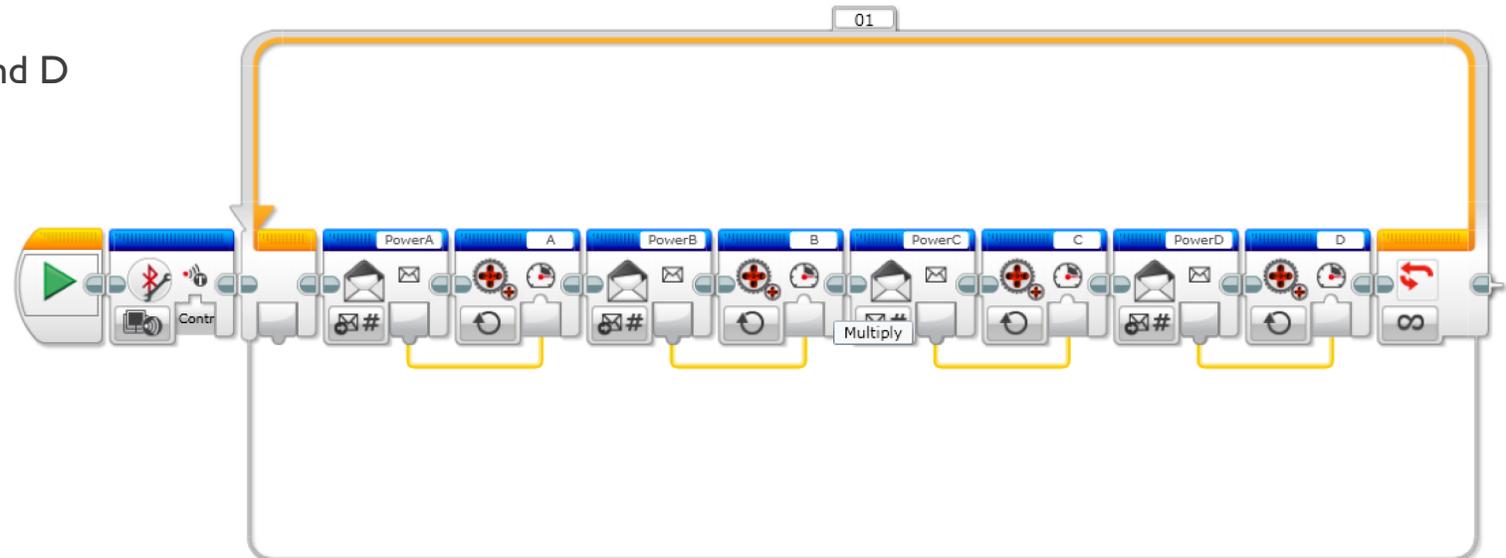
CHALLENGE 2 QUADCOPTER CODE
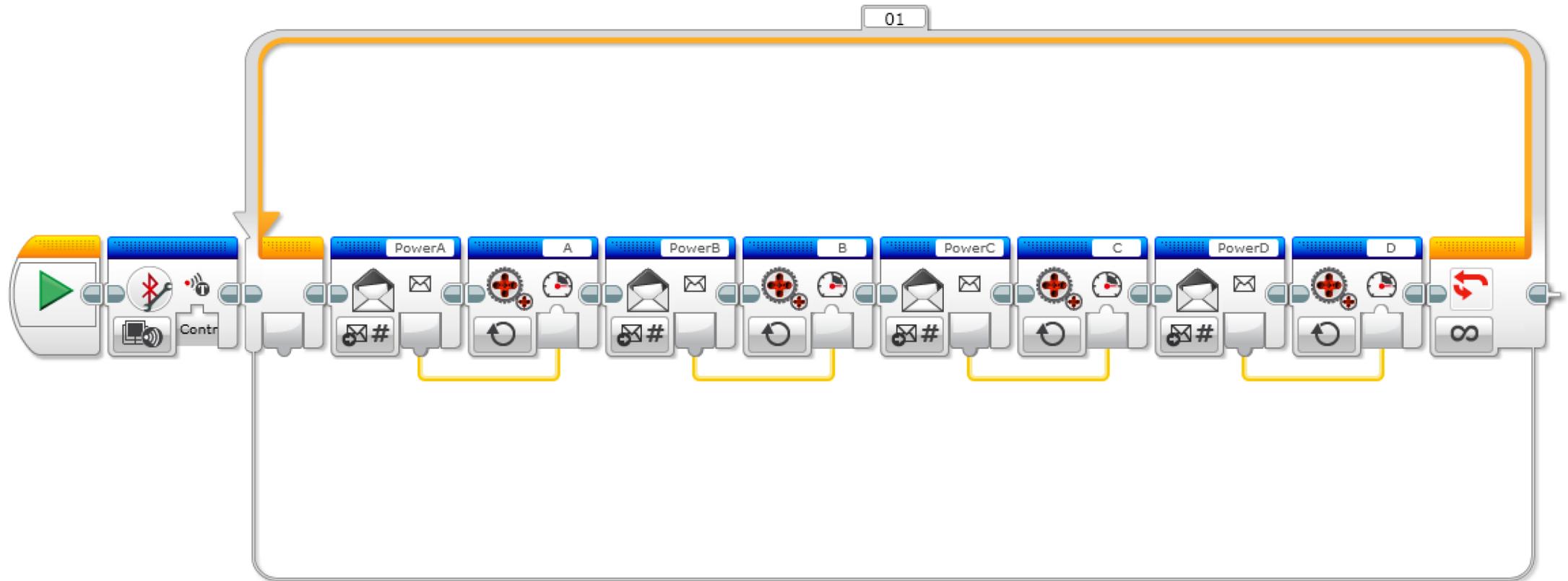
CHALLENGE 2 – SETUP

Now lets look at the controller program. The key steps are:

1. We will use the two touch sensors to control the power of the Quadcopter blades

    - A variable called Power will store this value

2. The motor dial will determine if the blades go forward or backward

3. The middle brick button will determine if alternate blades rotate in opposite directions

    1. A variable called Counter Rotation will store 1 if they are rotating in the same direction and -1 if they are in opposite directions

CHALLENGE 2 – SETUP

Now lets look at the controller program.

1. In the Controller program, create two numeric variables, "Power" and "Counter Rotation"

2. Write the "Power" variable to 50 and the "Counter Rotation" variable to 1

3. Reset the rotation sensor for motor A since the motor rotation will be used for the left toggle

4. Create a loop
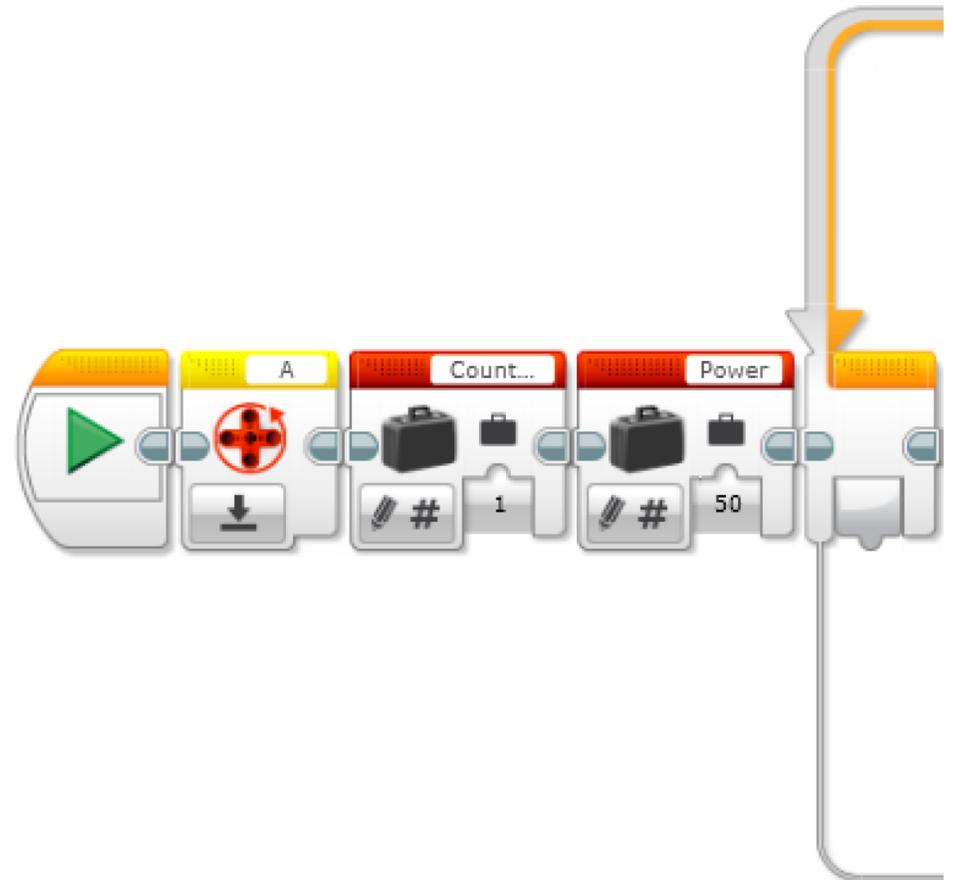
CHALLENGE 2 - RIGHT JOYSTICK

The first part of the loop controls the power.

1. Add two switches into the loop

2. Make sure they are in Touch Sensor – Compare – State Mode

3. Set the first switch to Port 1 and the second switch to Port 4 (The ports for the touch sensors)

4. In the true statement on the first switch, read the "Power" variable, add 1 to it using a math block and write the output back into the variable

5. In the true statement on the second switch, read the "Power" variable, subtract 1 from it using a math block and write the output to the "Power" variable
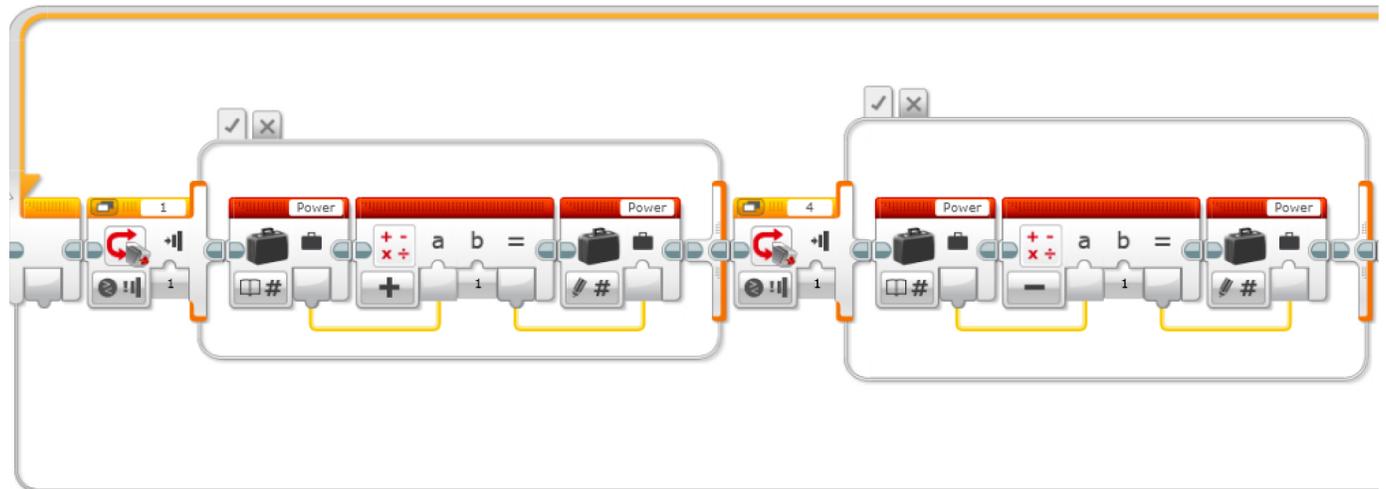
CHALLENGE 2 - LIMITING THE POWER VARIABLE

1. Read the "Power" variable

2. Drag the data wire into a compare block and make it check if the variable has exceeded 100

3. Draw the data wire for the output into a switch in logic mode

4. In the true statement of the switch set the "Power" variable to 100

5. Add another compare block after the switch that checks if the variable has gone below 0

6. Draw the data wire for the output into another switch in logic mode

7. In the true statement of the second switch set the "Power" variable to 0
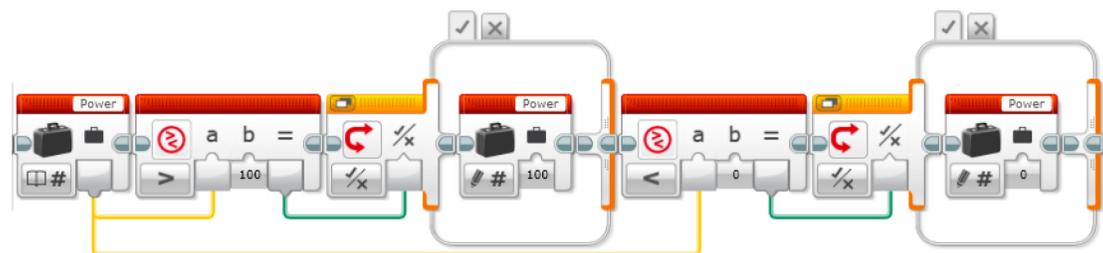
CHALLENGE 2 – LEFT TOGGLE

1. Add a switch and set it to Motor Rotation – Compare – Degrees

2. Set it to Port A and set the parameters to greater than or equal to 0

3. In the true statement, add a constant and set it to 1

4. In the false statement, add a constant and set it to -1

We will use this 1/-1 to control the direction of the motors.
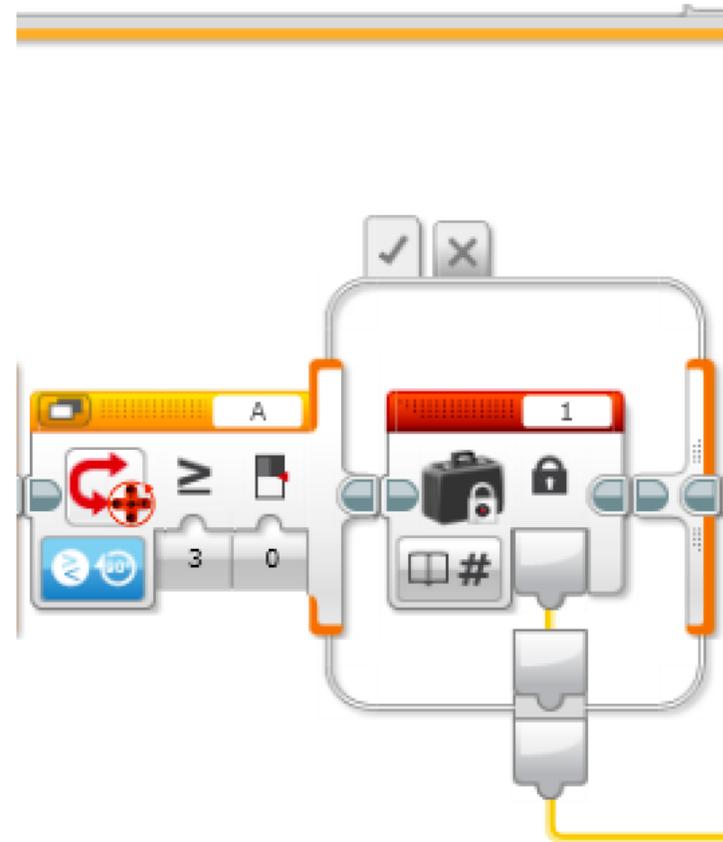
# CHALLENGE 2 – SENDING POWER LEVELS FOR MOTORS A & C XXX

- Add a switch in Motor Rotation - Compare – Degrees on Port A

- Set the parameters to greater than or equal to 0

- In the true statement, add a constant set to 1

- In the false statement, add a constant set to -1

- After the switch, read the "Power" variable

- Multiply the variable by the constant in the switch (1 or -1)

- Drag the data wire of the output into a Display Block on Text – Grid mode

- Drag the data wire into two separate Messaging Blocks set to Send – Numeric mode. The messages should be sent to the "Quadcopter" brick and the message titles should be "PowerA" and "PowerC"
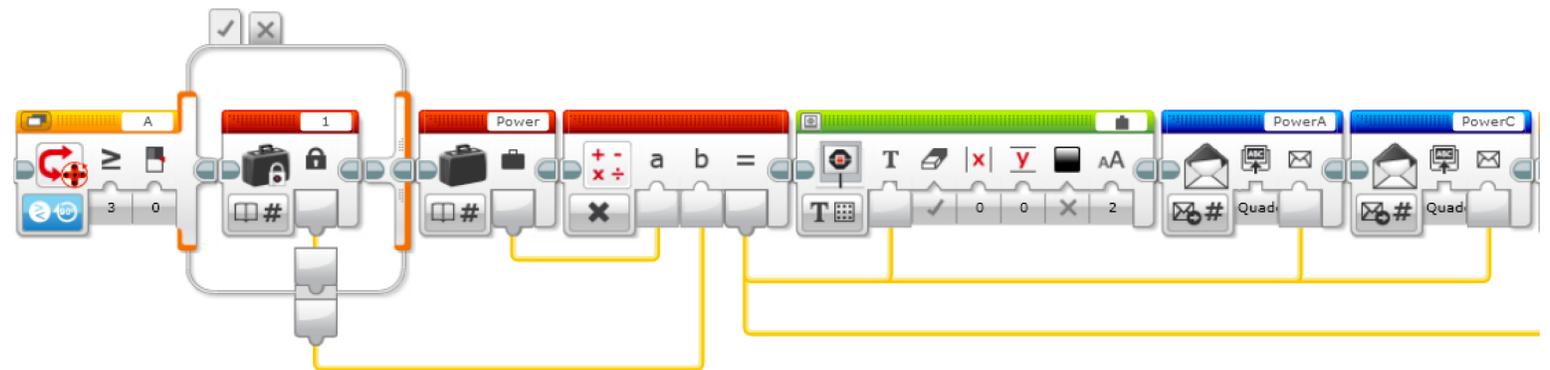
CALLENGE 2 – COUNTER ROTATION

Next, we need to determine what power to use for the other pair of blades. The Counter Rotation variable will be 1 or -1 based on whether the blades spin in the same or opposite directions from motors A & C.

1. Add a switch and set it to Brick Buttons– Compare

2. Set the parameters to check if the center button (id 2) is bumped

3. In the true statement of the switch, read the "Counter Rotation" variable, multiply it by -1 and write the output back into the variable
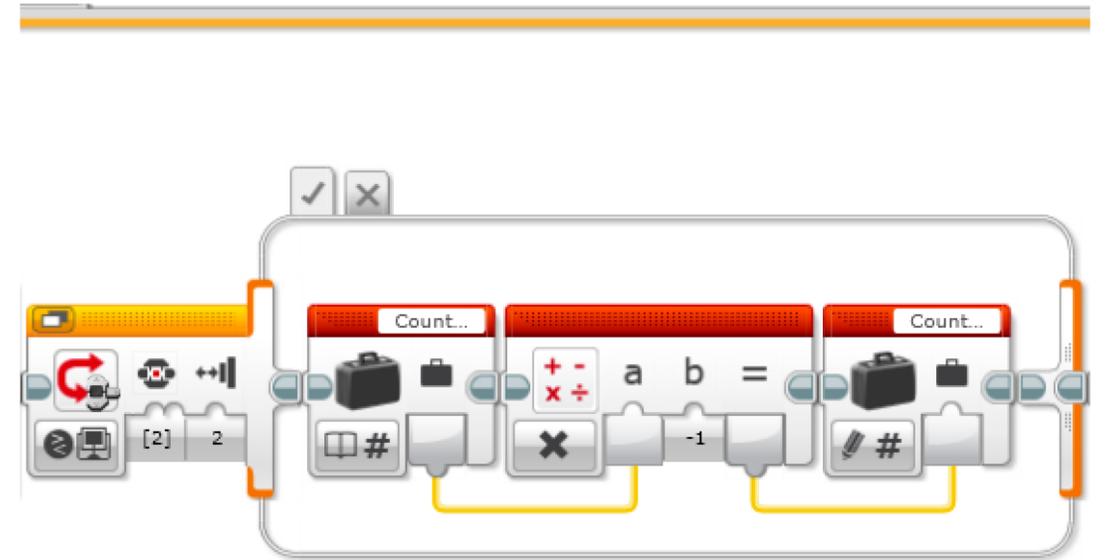
CHALLENGE 2 DISPLAYING AND SENDING THE DATA

1. We now take the "base" power that was computed and multiply this by the "Counter Rotation" setting

2. Next, add a switch in Numeric mode; with the counter rotation variable as input. Make two tabs in the switch and name them 1 and -1

   - In the "1" tab, display the text "Normal Rotation" with (X, Y) = (4, 6) and Font: 1. Make sure to set the "Clear Screen" parameter to False

   - In the "-1" tab, do the same thing, but display the text "Counter Rotation"

3. Drag the output calculated in step 1 on this slide into two separate Messaging Blocks set to Send – Numeric mode. The messages should be sent to the "Quadcopter" brick and the message titles should be "PowerB" and "PowerD"