Lecture 7: Educational robotics. Different Ways of moving: Synchronization, Regulated power, Ramp UP & down

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Lesson Objectives

1. Learn about different blocks for moving the robot and when to use which block
2. Learn about power regulation, motor synchronization, and ramp up/down

Different Ways To Move

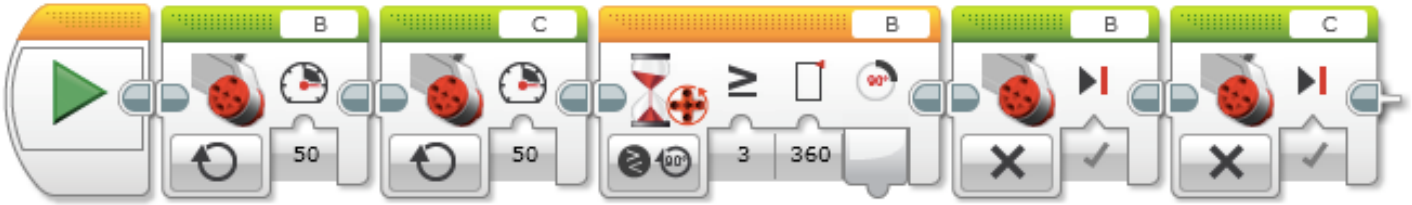
1

2

How are these different from each other in terms of the following?

- Power Regulation
- Motor Synchronization
- Ramp up/ramp down

3



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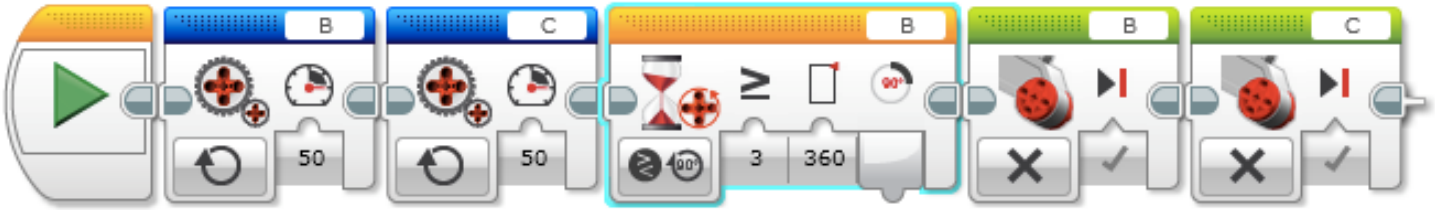
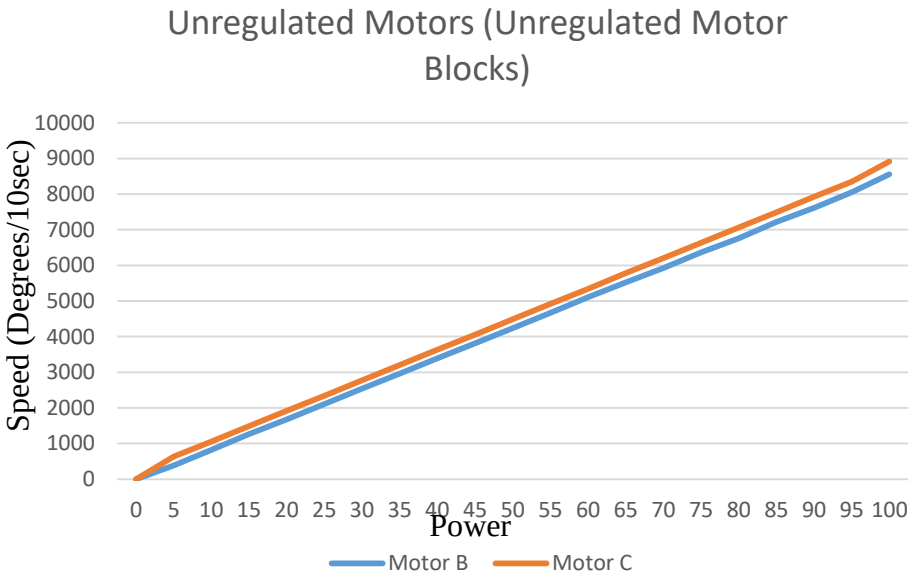


Regulated Power

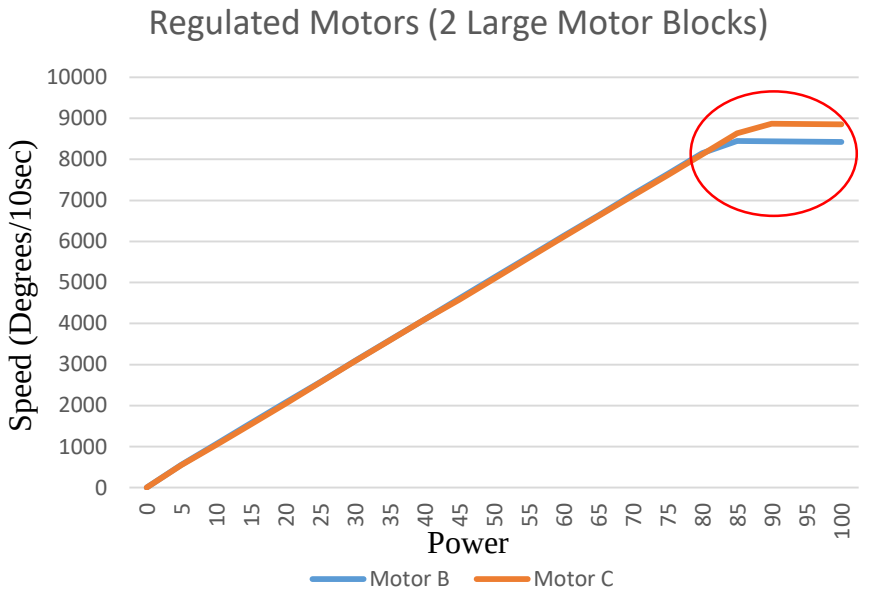
- Regulated power tries to move the robot at a fixed target speed. It uses PID control internal to achieve this goal.
- When the robot has trouble moving because it is heavy, it is moving uphill, its battery is dead, or it is blocked, power regulation gives more power to the motor to reach its target speed
- This is good for ensuring that the robot is moving at a predictable speed

- **Why would you want to use unregulated power ever?**
- If you want the robot to push against something and stall (give up)
- If you are implementing your own custom PID Control you probably don’t want the built in PID control to interfere with yours.

Data: Regulated Motors



The input to the unregulated motor block specifies the power given to the motor. The two motors perform differently at the same power because no two motors are alike (note the gap between the lines). As the battery power goes down, all speeds go down (the slope will decrease for both lines)



The input specifies speed. Power regulation adjusts power to achieve the requested speed (note that lines overlap mostly). This works up to the limit (max speed) of each individual motor (note lines split at max power). This is true regardless of battery level. The max speed will decrease at lower battery levels but the slope will stay the same.

Synchronized Motors

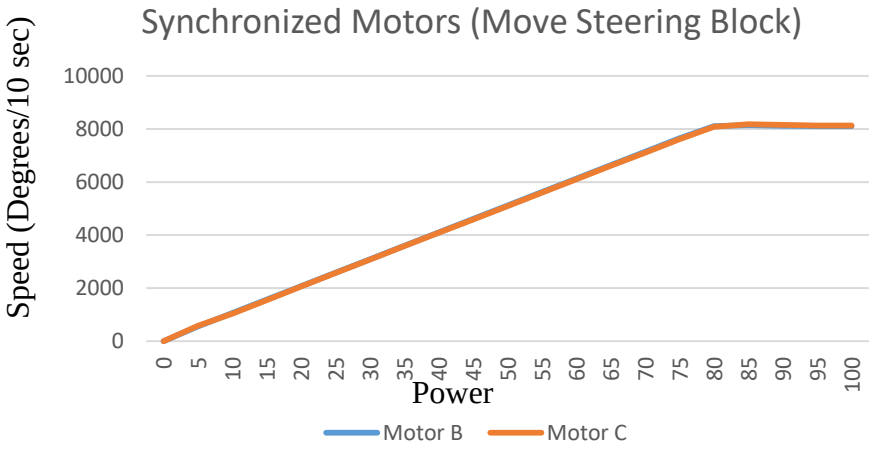
Synchronized motors makes sure that both motors turn the same amount (or at some fixed ratio)

If one wheel gets stuck, it prevents the other wheel from spinning

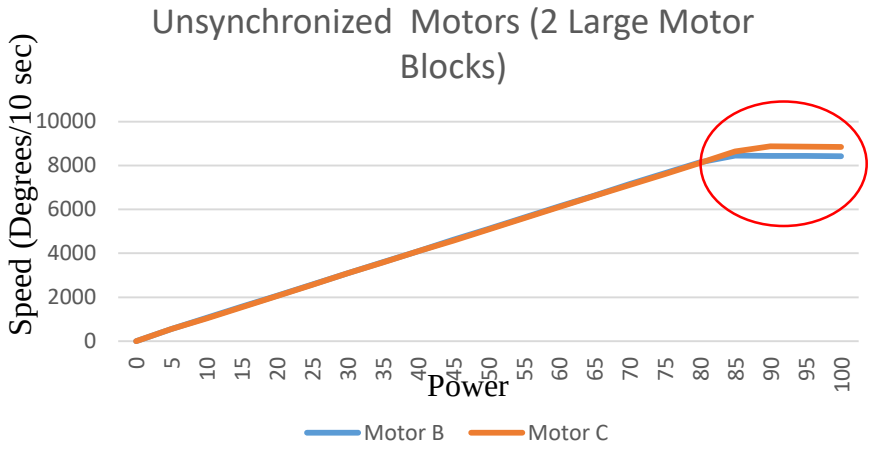
If you have the motors turning the same amount, it helps ensure that the robot moves straight when one wheel is slowed by friction or anything else

When you have synchronized motors with a ratio, it makes the robot make predictable and smooth turns

Data: Synchronized Motors



Both motors go the same distance. The two lines overlap.

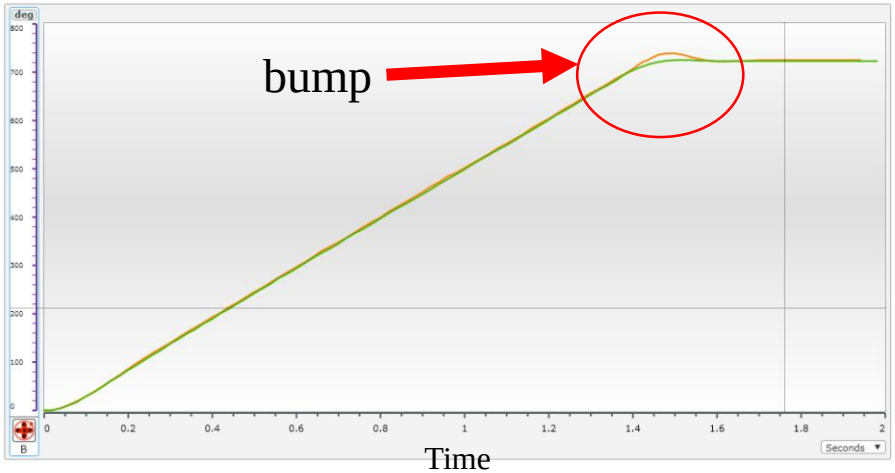


One motor is not able to keep up with the other. But this isn't fixed because they are unsynchronized.

Ramp Up / Ramp Down

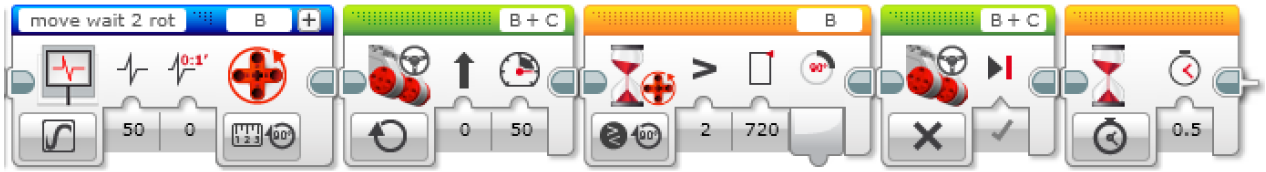
- Ramp up makes the robot speed up gradually at the beginning of a move
- Ramp down makes the robot brake gradually at the end
- Without ramp up/ramp down you might see the robot jerk at the beginning or end
- The robot will still adjust its motors after a brake to reach that target rotation sensor value but this may still be less accurate

Ramp Up / Ramp Down

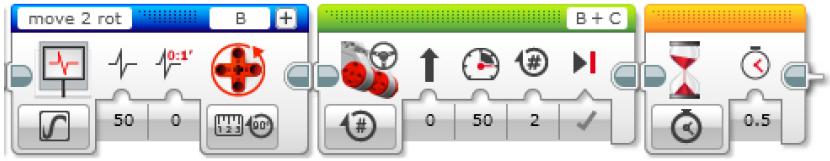


Move 2 rotations (green line) incorporates ramp up and ramp down to nicely stops after 2 rotations.

Move + Wait (orange line) has a hard stop which causes the robot to go past 2 rotations and then back up (notice the bump in the graph)

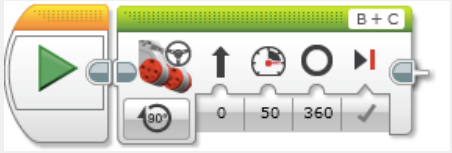
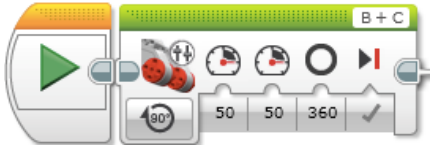
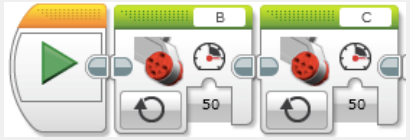
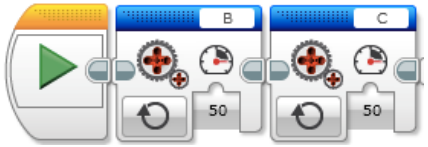


Move + Wait



Move 2 rotation

Different Ways To Move

		Regulated Power	Synchronized Motors	Ramp Up / Ramp Down
1		✓	✓	✓
2		✓	✓	✓
3		✓	X	X
4		X	X	X

Moving Degrees vs. Seconds

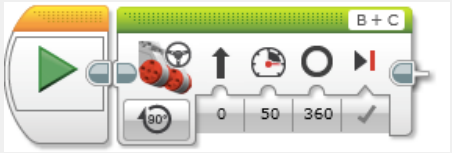
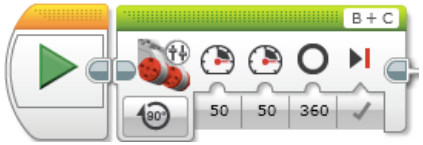
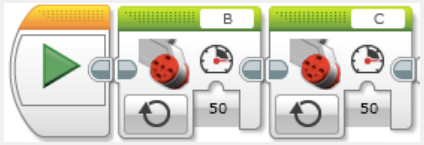
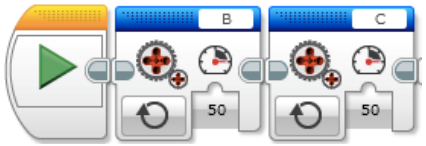
Move Degrees/Rotations

- Block does not complete until the target degree rotation is reached
- So what if the robot gets stuck somewhere on the mat?
- Program stalls and never goes to next block
- You will have to save the robot and take a touch penalty

Move Seconds

- Less accurate for robot movement
- Distance traveled depends on speed, battery level, weight of robot
- You have to remember this when deciding if move secs should be used.
- However, can help avoid stalls
- E.g. Can be useful if your attachment arm gets stuck

Discussion Guide

Fill in the chart below:		Regulated Power	Synchronized Motors	Ramp Up / Ramp Down
1				
2				
3				
4				

References

Benedettelli, D. (2014), *THE LEGO® MINDSTORMS® EV3 LABORATORY build, program, and experiment with wicked cool robots*. William Pollock, USA.
Griffin, T. (2014), *THE ART OF LEGO® MINDSTORMS® EV3 PROGRAMMING*. No Starch Press, USA.
Valk, L. (2014), *THE LEGO® MINDSTORMS® EV3 DISCOVERY BOOK*. William Pollock, USA.
Filipov, S.A. (2013), *Robotics for children and parents*, Fradkova, A.L., St. Petersburg.