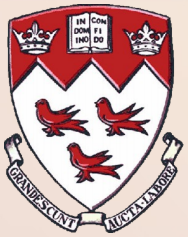

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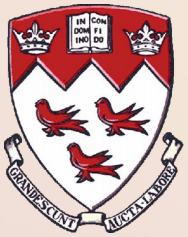
Wall Following

ECSE 211 – Design Principles and Methodology

Feedback Controllers



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- Feedback controllers, in sense of the NXT, take information read back from the sensors and modify one of the robot's attributes according to the values read.
- In the following slide, we have a photo of the general feedback loop, in which a standard input is summed with the feedback information, and the robot's motor controllers are modified accordingly.
- This tutorial will cover the bang-bang and p type controllers.

Feedback Controller

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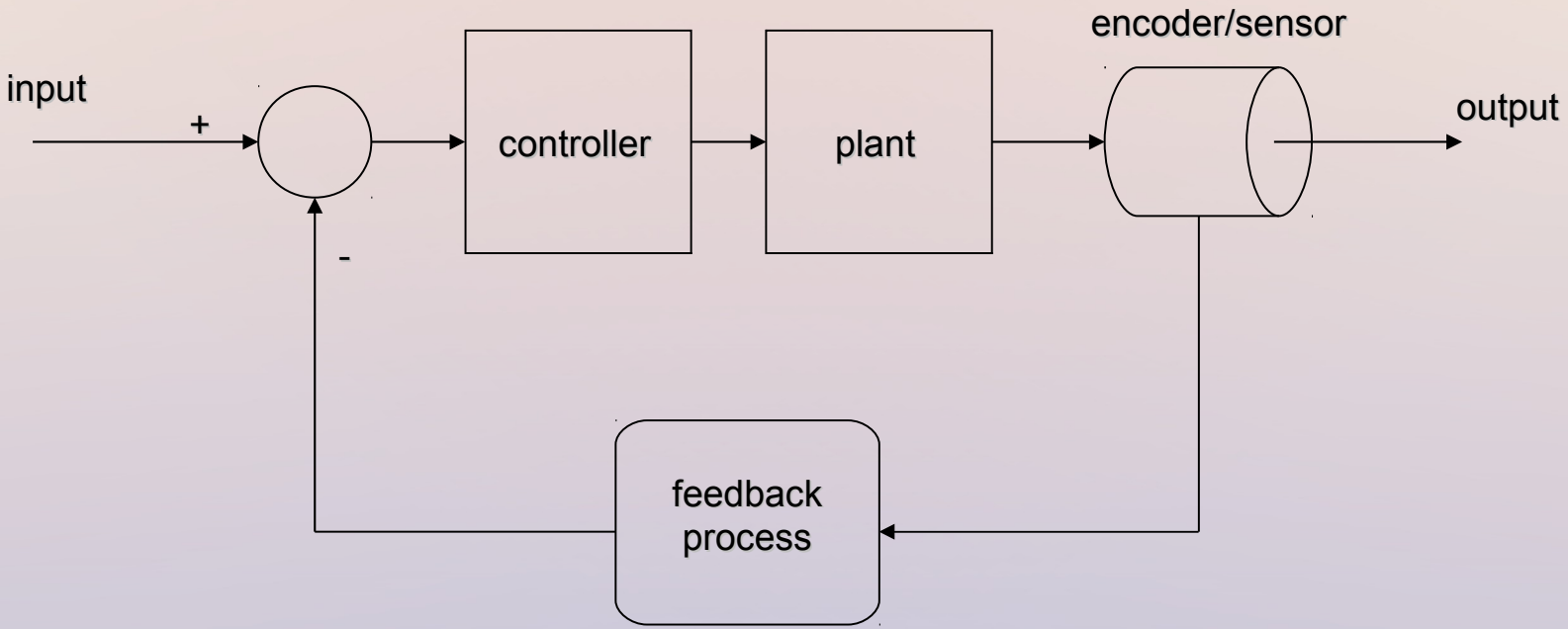
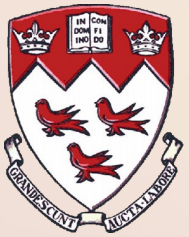


Controller Types



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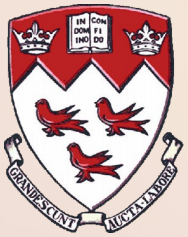
- There are two main controller types covered for this lab. They are:
  - Bang-bang Type
  - P Type
- The difference between the two is that the P controller will increase the speed applied to outer wheel based on the distance read by the sensor. The bang-bang controller will only apply one level of speed, similar to an “off-on” switch.
- For this lab, you will need to complete both.

The Bang-Bang Controller



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- A bang-bang controller (also known as an on-off controller) is a feedback controller that switches suddenly between two states (on/off)
- For this lab, the bang-bang controller will make one wheel (the outer) go faster when the robot's ultrasonic sensor detects that it's readable distance has increased above a threshold. For both controllers, the inner wheel remains constant. It is up to you if you'd like to reverse this.

Bang-Bang continued

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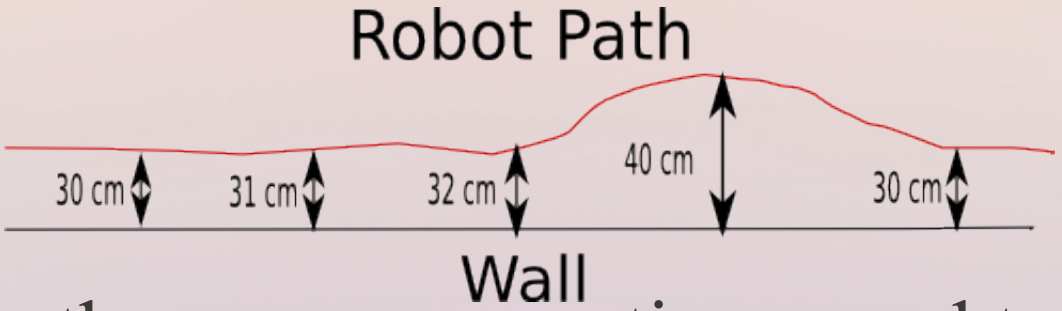
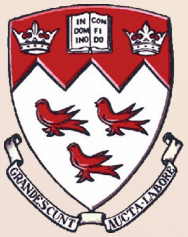
- The following image shows an example robot path in relation to a flat wall. The arrows denote the distances that the ultrasonic sensor reports.



- For this path, some assumptions need to be made. First the distance we wish to optimally keep from the wall is 32 cm (band center), second the error in either direction allowed before an action occurs is 5cm (bandwidth)

Bang-Bang continued



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- As you can see, the robot will stay relatively straight until (band center) +/- (bandwidth) is reported by the ultrasonic sensor.
- The robot will then trigger an action, this is usually simply where one wheel's rotational velocity is increased to allow the robot to turn. Once the ultrasonic reports something within the threshold again, the bang-bang controller will return the normal “straight” speed

Bang-Bang continued

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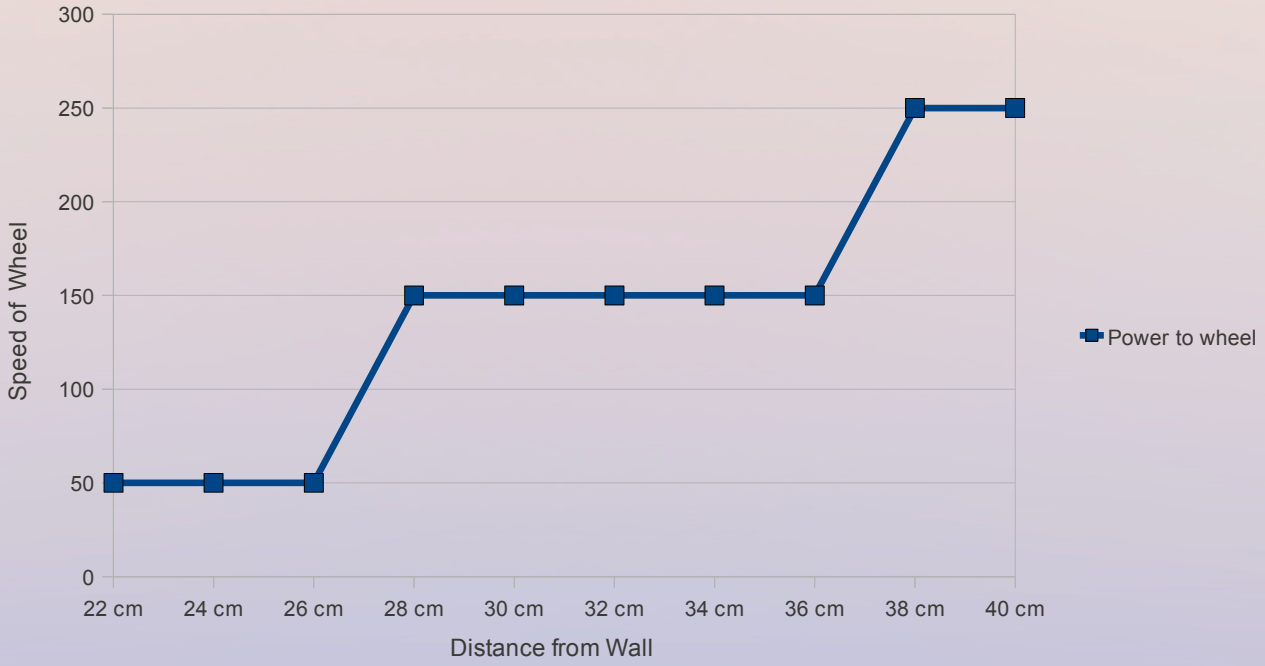
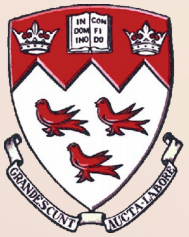
- A plot of the bang-bang controllers motion of the robot might look like the following plot. As you can see, as long as the ultrasonic reads a distance between (band center) +/- (bandwidth) the robot's speed of the outer wheel matches that of the inner wheel.(150) However when the robot reports a distance outside this, the outer wheel will speed up or slow accordingly.



P Controller



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- In contrast to the Bang-Bang Controller, there is another type which we will cover for this lab. It is called the P Controller. The P Controller is a linear scalar instead of an on/off switch. This means that as the robot travels further from the wall, the power applied to the outer wheel will be increased.
- This will give you a linear scale for the speed applied to the outer wheel, versus the distance from the wall.

P Controller continued

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- For the following plot, assuming band center = 32 cm, we can show that the speed vs. distance is linear. We must also assume that both wheels, when going forward, travel at 150 speed. Therefore at 32 cm, the robot travels straight. However when the robot travels below the threshold, the outer wheel will travel slower, causing the robot to turn away from the wall. Also when the robot travels farther from the wall, the outer wheel will speed up, causing the robot to turn closer to the wall.