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Robot Design Ideas

CS 8990-8650

Introduction to Robotics & AI

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Class

Will

Start

Momentarily...

Light Navigation

- A few comments about using the light sensor for navigation.
- Strategy that seems to be difficult: some designs have tried to mount the light sensor on a moveable arm at the front of the 'bot, so that when "looking" for the black line, the sensor can be moved to search, without moving the entire chassis.
- This idea hasn't paid-off, partly because it requires that in addition to the orientation of the bot, the orientation of the light sensor arm must be planned.
- Generally easier to just move the chassis when searching.

- Using the light sensors for control of path
- Light sensors give a numerical value for how light-dark it is perceiving.
- If following a black line, how do you know which direction you are edging toward? Decreasing darkness does not indicate direction.
- Move the light sensor from side to side: "scanning". (humans do this, but we also have peripheral vision)
  - Slower, takes time
  - Requires another motion – another motor and control

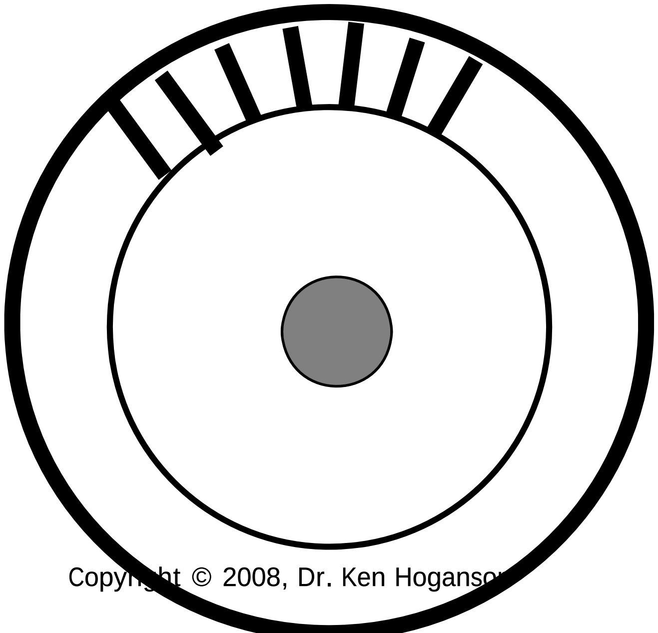
Navigation

- With a single sensor, the bot will wander off the stripe, then will be turned back to the stripe.
- The robot follows a wavy course, rather than straight.
- Think about a protocol or plan to decide which direction to turn the bot when its lost (or losing) the black line. You don't want to come to a full stop and search every time.
- When the line is completely lost, the bot may need to search for it – circles/sprirals
- Search will be useful for turning corners (there are two)
- Your code must be constantly monitoring the light sensor while traveling.

- Another idea for teams – use two light sensors, bracketing the black stripe.
- Slipping to the side will yield one sensor seeing more black, while the other continues to detect white.
- Can then compensate accordingly
- Variation: point the sensors at the edge of the black stripe, and monitor the “gray” value
- It is interesting to realize how much thought and processing and complexity is involved in simple control issues. Animals have very sophisticated perception and control of many body parts, extremities, degrees of motion, touch sensitivity, vision accuracy, that far exceeds our robotics capabilities at present.

Another Control Idea

- Using the light sensors to measure the rotation of the wheels, and compensate accordingly.
- Place black and white markings around a wheel, and use the light sensor to count the light changes as the wheels turn.
- Use this information to decide how to increase/decrease the power/pulses to each motor.



Motors

- Use Document camera for discussion on motors and stepper motors.
- From "Introduction to Robotics: Analysis, Systems, Applications", Saeed B. Niku

- Consider the idea of using gearing to slow the motor speed for more precise control, and for more power.
- Simply reducing the voltage applied to the motors will slow the motor, but also reduces the power or torque.
- At low voltages (and low speeds), the motor has so much less power, that it may not overcome the inertia of the object it is trying to move.

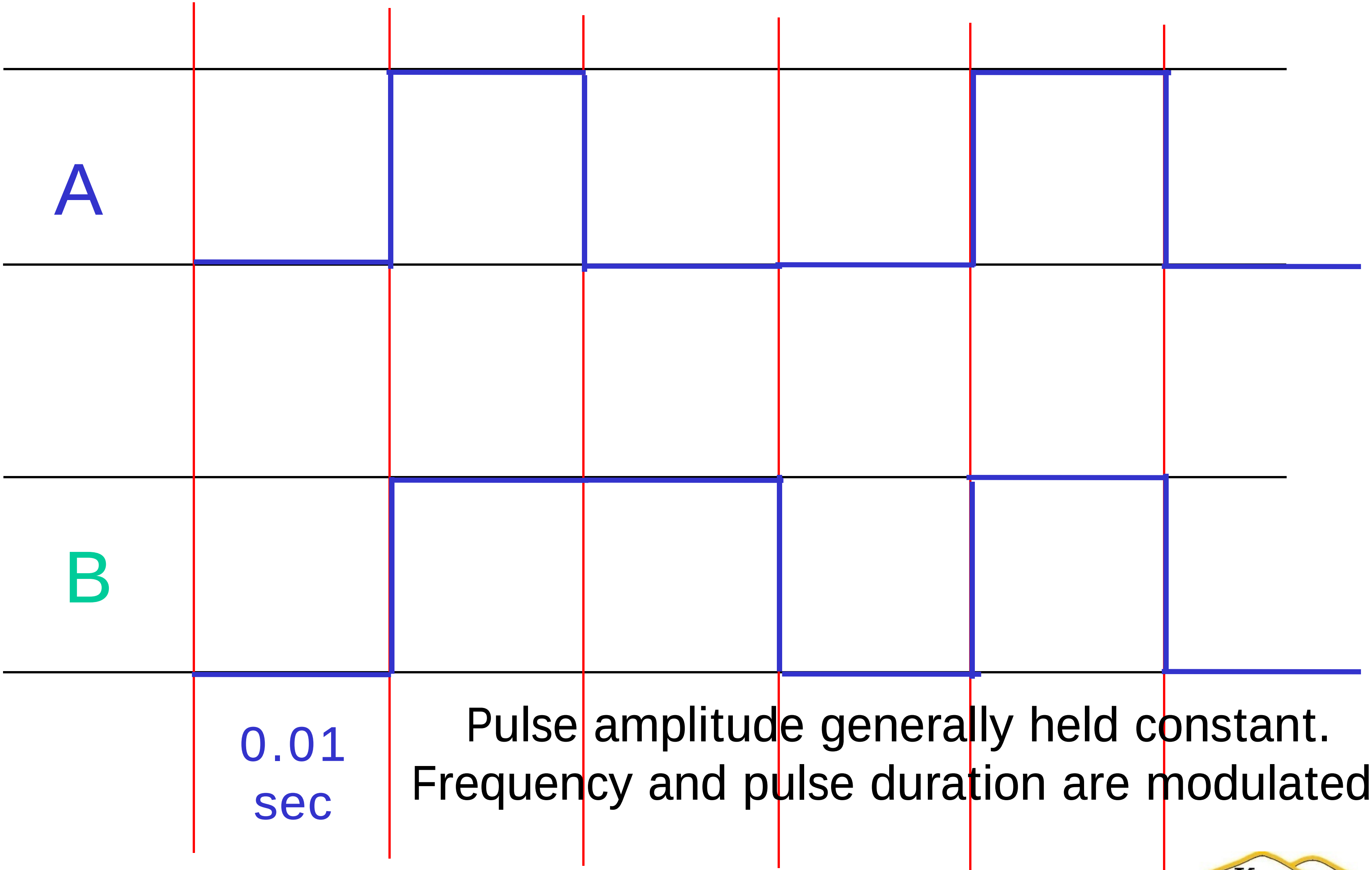
Pulse Width Modulation

- Another form of motor control is possible with computer control.
- Pulse Width Modulation, where pulses of current are delivered to the motors.
- Rather than modulate the voltage to the motors, the width (or duration) of the pulses are modulated.
- This is similar to a data communication technique you may have encountered, called PCM or pulse code modulation.

Important Advantage

- The pulses to the motor are delivered at full voltage.
- This means that maximum force and torque are available to overcome inertia.
- The pulses are delivered with very brief waits between pulses,
- so the average overall voltage delivered to the motor is lower –
- so the overall speed is slower, just as if the voltage was being modulated directly.
- The pulses must be delivered quickly in order to make the motion smooth.

Modulating Pulse Width



Pulse amplitude generally held constant.
Frequency and pulse duration are modulated.

Compensating for motors

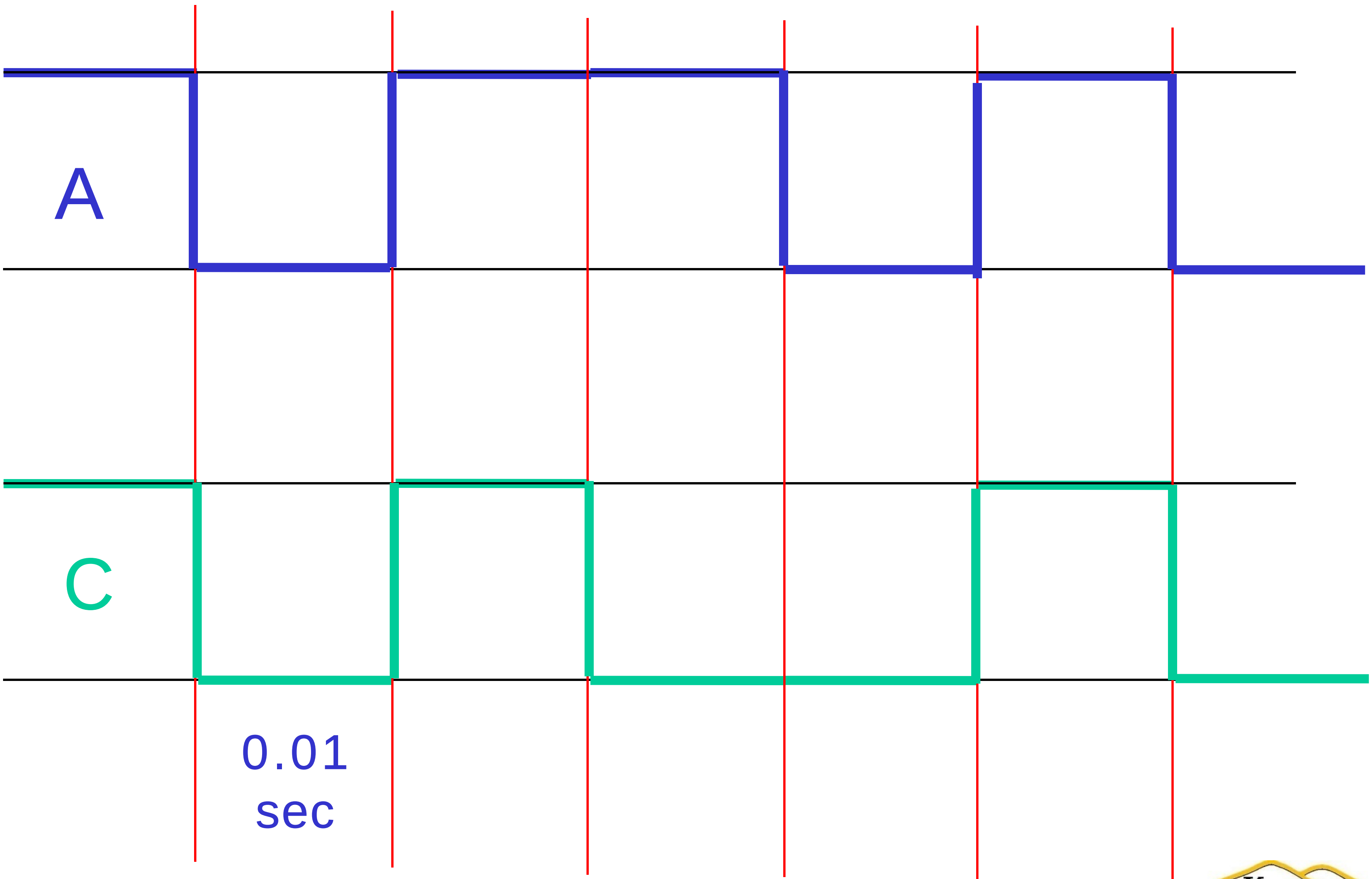
- The motors in our kits may not respond consistently – requiring and active control mechanism.
- One aspect of successful designs is that the vehicle is steered by the controlling the speed of the wheels turning, rather than actually "steering" the front or back wheels.
- An alternative design that avoids this control issue, might be to use one motor to turn an axle powering two wheels, and use another motor to control the steering.
- One student attempted using the rack pieces to build a kind of "rack and pinion" steering.
- You may still need to investigate the following pulse width modulation for the precise control it provides.

- For motors that behave differently, Pulse Width Modulation provides a way to equate their turning speeds precisely, without loss of power and torque.
- Pulse of different duration can be applied to the two motors – the slower motor can get slightly longer pulses.
- Testing is required to fine-tune the ratio of pulses delivered to the different motors.

Different Pulse Widths

- A way to approximate this technique, is to apply an “extra pulse” to the slower motor.
- For instance, we might do something like the following:
  - Pulse to A and C for 0.01 sec
  - Wait 0.01 sec
  - Pulse to A and C for 0.01 sec
  - Pulse to A for 0.01 sec
  - Wait 0.01 sec
  - Pulse to A and C for 0.01 sec
  - Wait 0.01 sec
- The effect is to provide A with 4 pulses, while C got only three pulses, over a period of 0.07 sec.

Graphical Description



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Today's

Lecture.

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