

FRC Programming

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Useful Websites

- <https://wpilib.screenstepslive.com/>
- <https://www.chiefdelphi.com/>
- <https://www.reddit.com/r/FRC/>

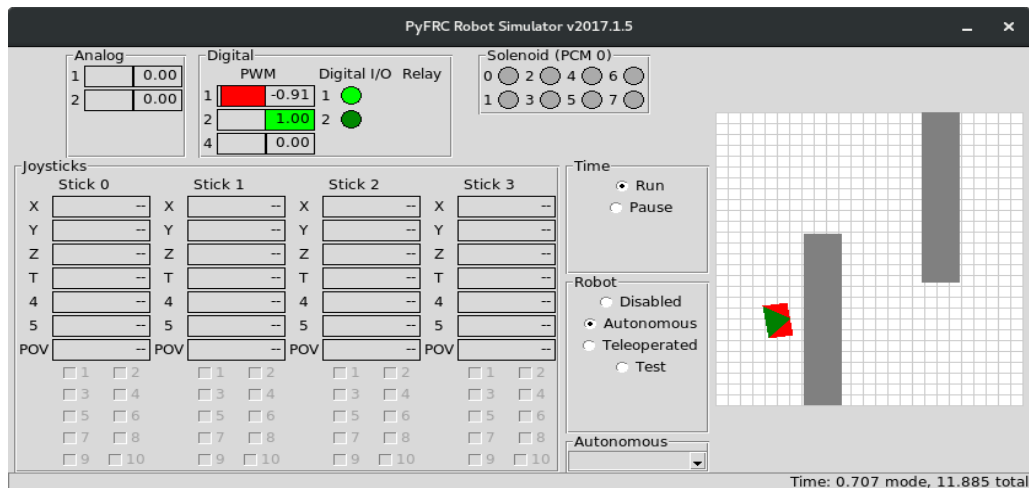
Getting Started

Good Practice

- Code Review
- Software testing (<https://youtu.be/vmRFiF9hd2E>)
 - Unit tests
 - Continuous testing
 - Avoid developing subsystems that define hardware
- Simulation

Python?

- <https://robotpy.readthedocs.io/>
- Simulation



I, as the lead programmer on 865 last year, spearheaded a python initiative on my team. We fell in love with robotpy, much like your programmer did, even though our school's CS curriculum taught only java.

Python was extremely flexible, and though the development community for FRC Python is much smaller, it has near-complete WPilib feature parity with the Java and C++ apis. Any code that runs in Java or C++ can be ported to Python in a matter of minutes - the only difference is syntax.

Python in FRC is entirely legal, though it's not officially supported. While you may be worried about using Python, our team loved it! It was super easy for vision, so I totally agree with your programmer there. Python also works really well on the RoboRIO because it's a linux system. Java, while it works totally fine on the RIO, doesn't have as simple or rich of an ecosystem on linux devices. We also found that teaching Python to newbies was *much* easier than teaching Java. Our school's CS courses start in grade 11, so Python let us start teaching grade 9s programming without having to wait two more years.

I'd endorse Python, and I encourage your mentors to talk to your programmer about why he wants to make those choices and why he's so insistent on it. Maybe you'll come around to his side.

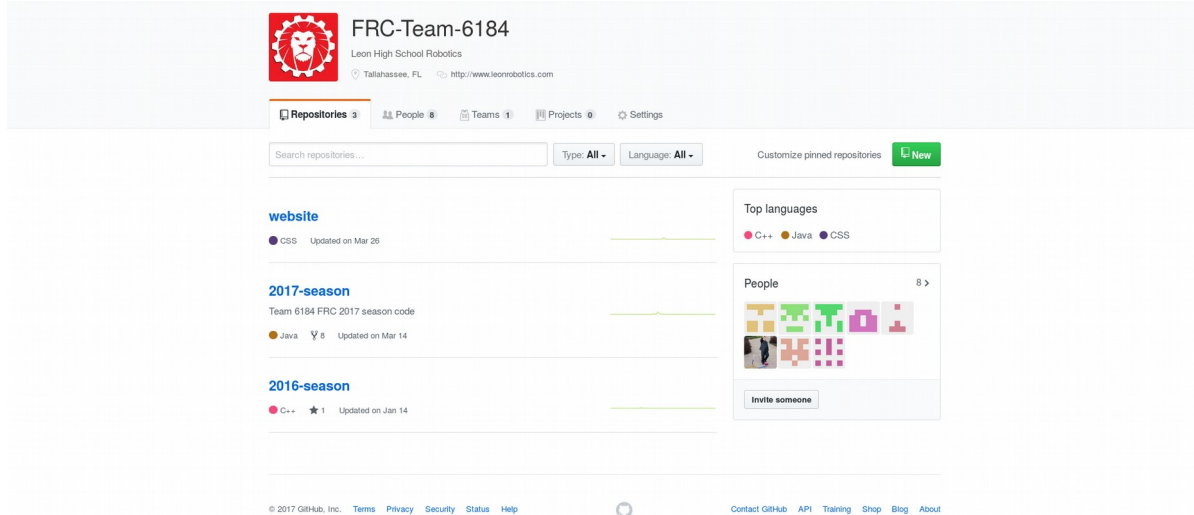
Software Collaboration

- Git

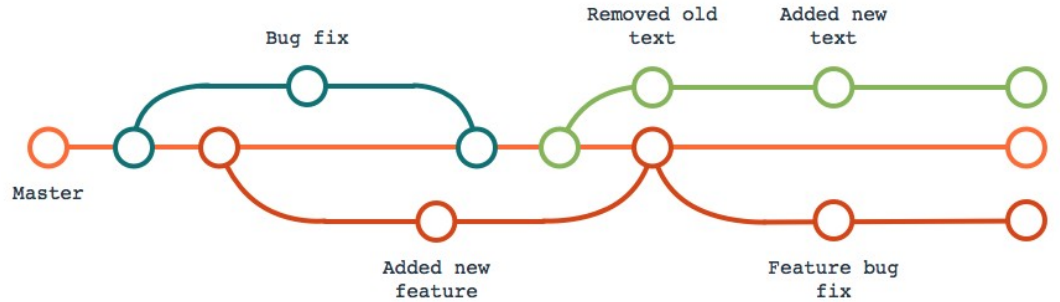
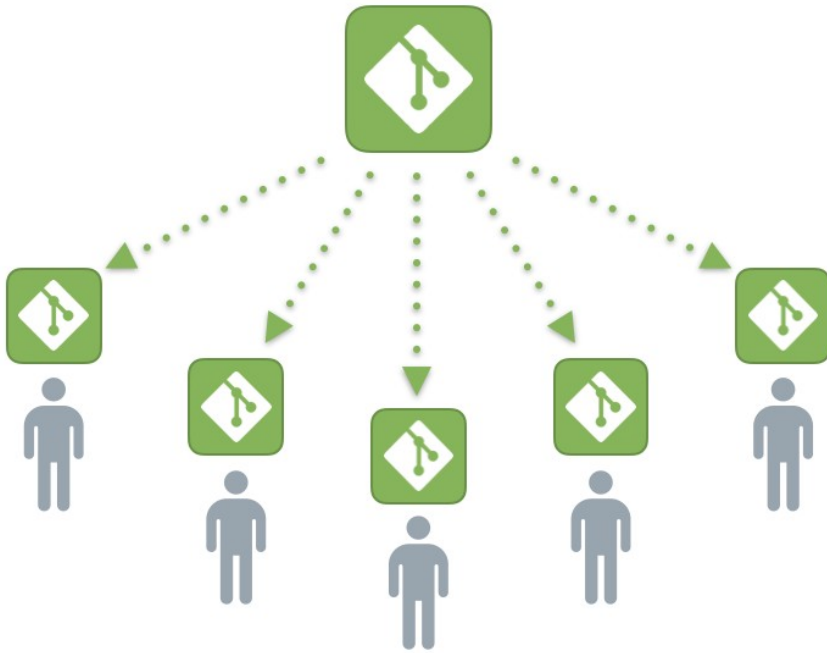
- GitHub
- GitLab
- Self-hosting

- Subversion

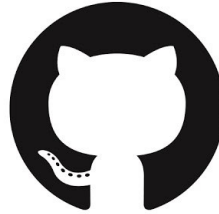
- Better for binary files (LabVIEW)



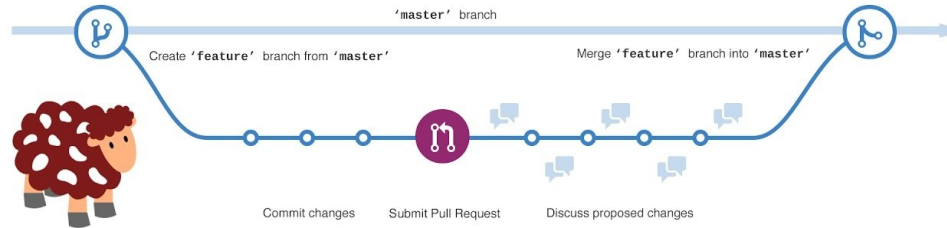
Software Collaboration



Software Collaboration



GitHub Workflow



```
47 34      boolean isclickedright = stick.getRawButton(3);
48 35      boolean isclickedleft = stick.getRawButton(4);
49 -      if (isclickedright && ! isclickedleft){ //turn right
50 -          climb.setSpeed(.3);
36 +      if (isclickedright){
37 +          rotate_shooter.setSpeed(1);
51 38      }
52 -      else if (!isclickedright && isclickedleft){ //turn left
53 -          climb.setSpeed(-.3);
39 +      else if (!isclickedright && isclickedleft){
40 +          rotate_shooter.setSpeed(-1);
54 41      }
```


Computer Vision

- “Interdisciplinary scientific field that deals with how computers can be made to gain high-level understanding from digital images or videos.” - Wikipedia
- Recognition
 - Detect task elements and estimate pose
- Motion analysis

Computer Vision

- Object Detection
 - Pre-processing (Blur Image, Contrast)
 - Find features (lines, edges, ridges, blobs, corners..)
 - Segmentation (size, color, angle, etc)
 - High-level processing
 - Decision making

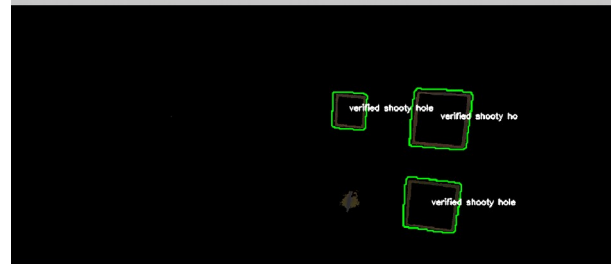
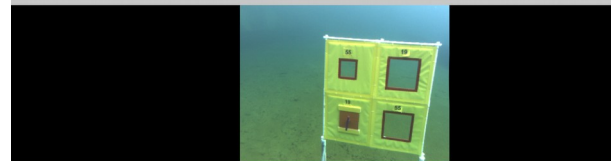
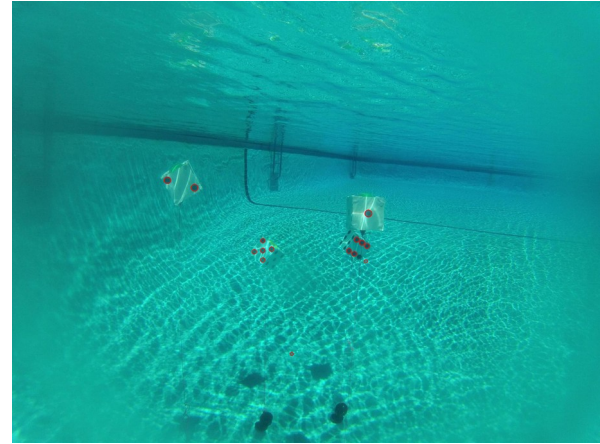
Computer Vision

- OpenCV

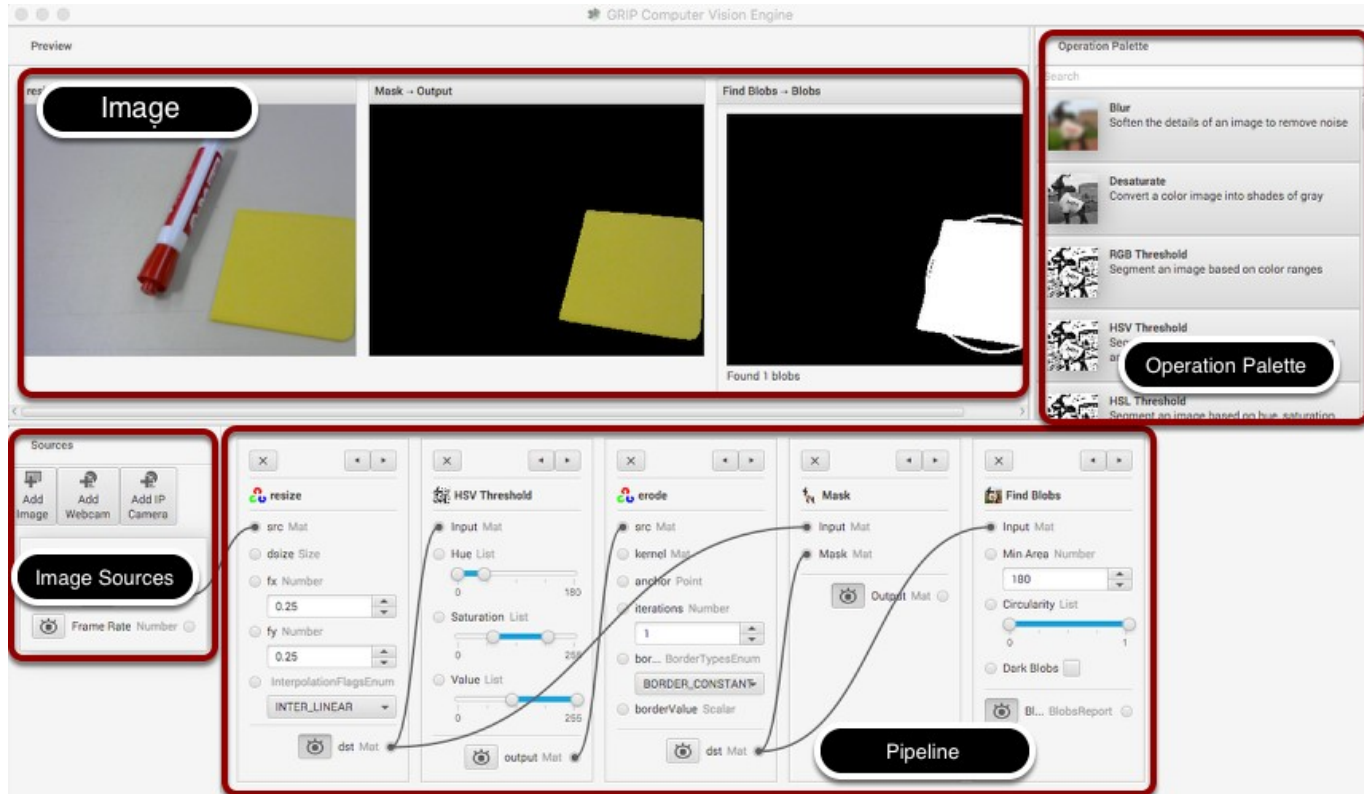
```
# load the image and resize it to a smaller factor so that
# the shapes can be approximated better
image = cv2.imread(args["image"])
resized = imutils.resize(image, width=300)
ratio = image.shape[0] / float(resized.shape[0])

# convert the resized image to grayscale, blur it slightly,
# and threshold it
gray = cv2.cvtColor(resized, cv2.COLOR_BGR2GRAY)
blurred = cv2.GaussianBlur(gray, (5, 5), 0)
thresh = cv2.threshold(blurred, 60, 255, cv2.THRESH_BINARY)[1]

# find contours in the thresholded image and initialize the
# shape detector
cnts = cv2.findContours(thresh.copy(), cv2.RETR_EXTERNAL,
    cv2.CHAIN_APPROX_SIMPLE)
```

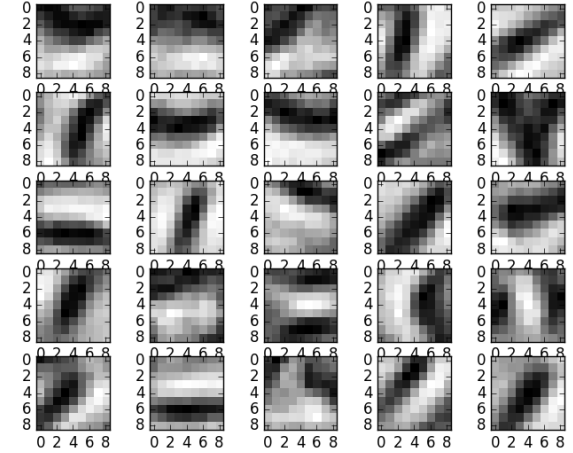


Graphically Represented Image Processing (GRIP)

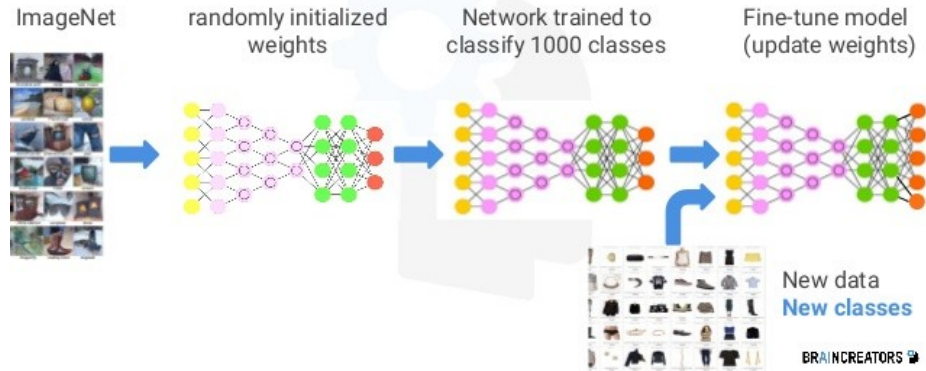


Machine Learning

- Deep neural nets
 - Convolutional neural nets
 - Transfer Learning



Transfer Learning

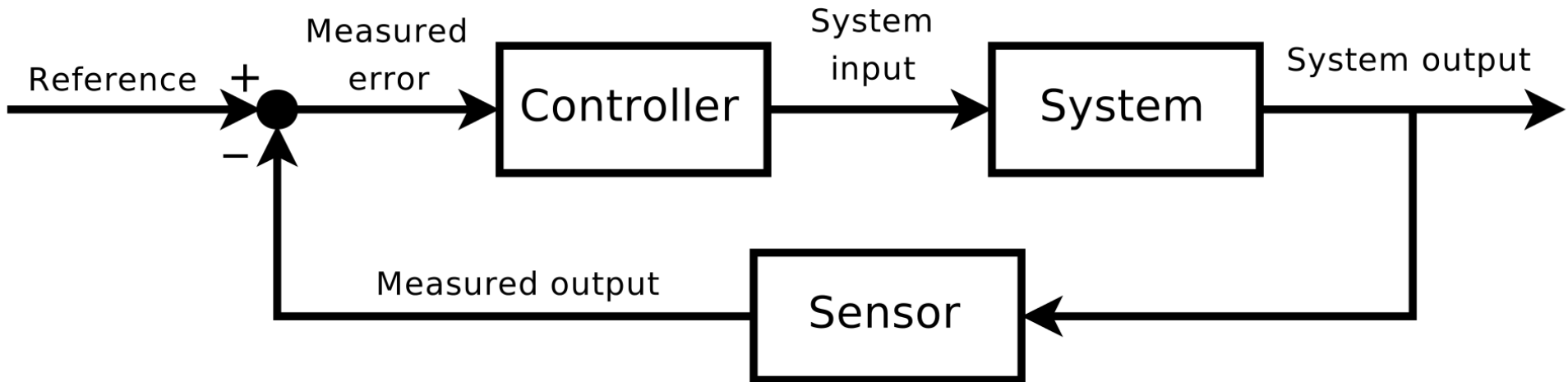


Deep Dream



Control Theory

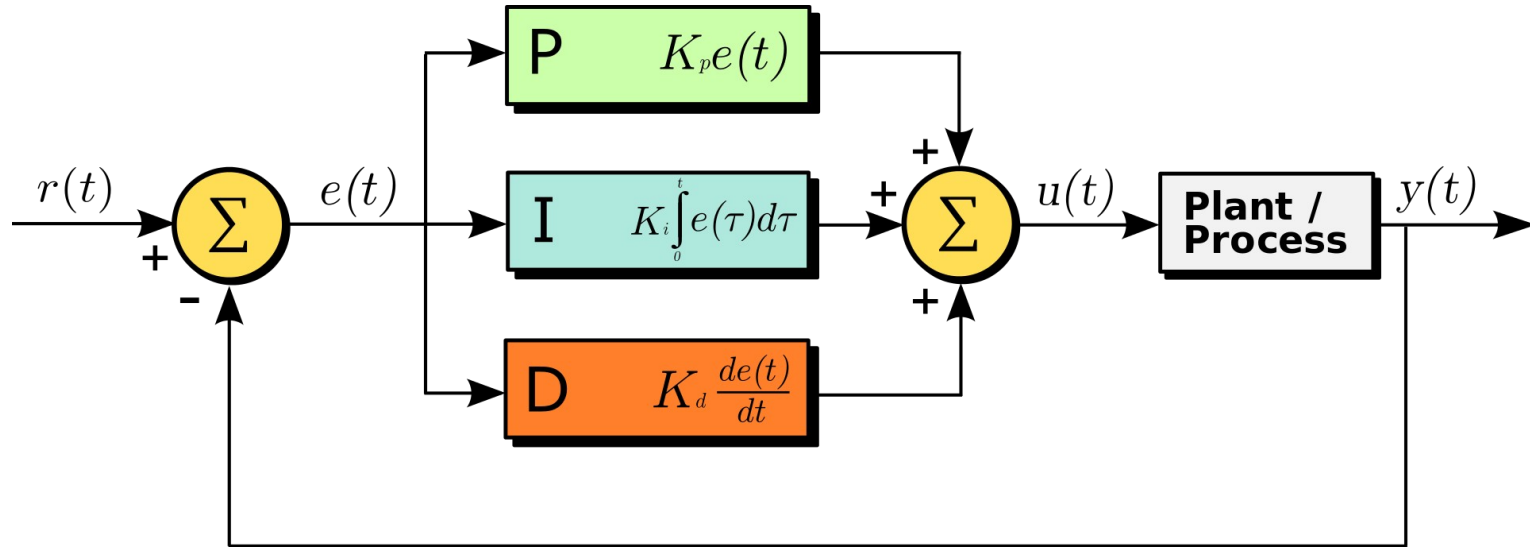
- “...A subfield of mathematics that deals with the control of continuously operating dynamical systems in engineered processes and machines.” - Wikipedia



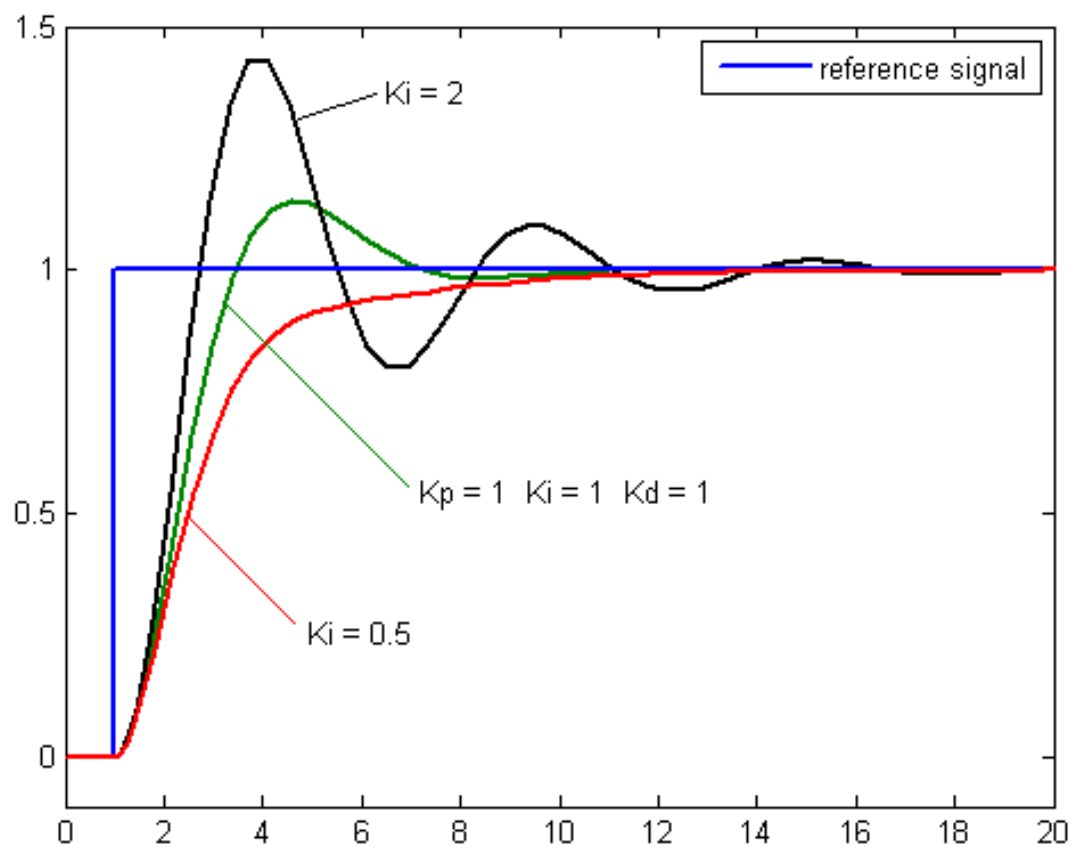
Control Theory

- LQR Control
- Bang-bang controller
- PID controller

PID Control



Tuning Gains



Any Questions?