WARG

Autonomy Meeting

- What is Autonomy?
- What does the Autonomy team do at WARG?

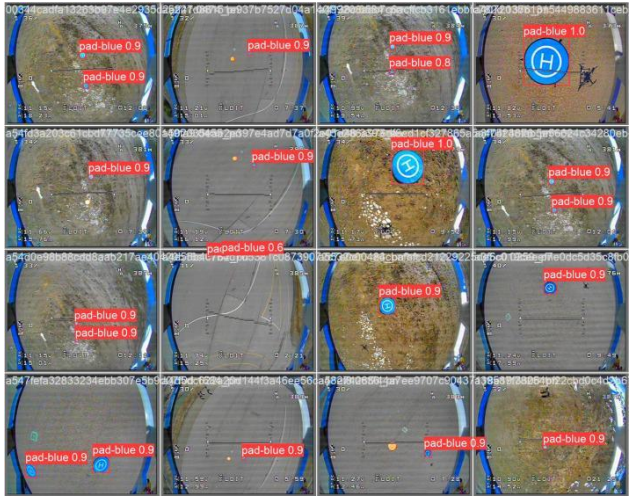
What is Autonomy?

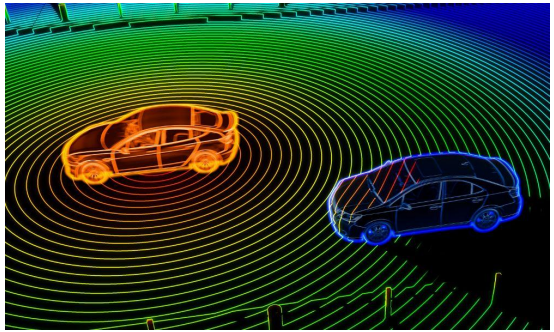
- Autonomy (in the domain of robotics) means equipping a robot with the tools it needs to **independently** operate in its environment.
- There are 3 components to Autonomy:
  - Perception
  - Decision Making
  - Controls

Let’s break down these 3 components.

Perception

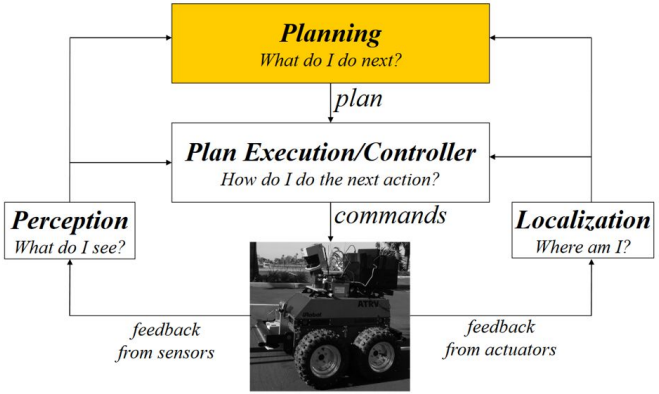
- Perception is everything related to the Camera and LiDAR sensors on the robot.
  - LiDAR stands for Light Detection and Ranging (used to determine ranges by targeting an object with a laser).
- Perception helps the robot develop an understanding of its environment and create a model of its world.
  - Object Detection is a common perception related task we do at WARG.





Decision Making

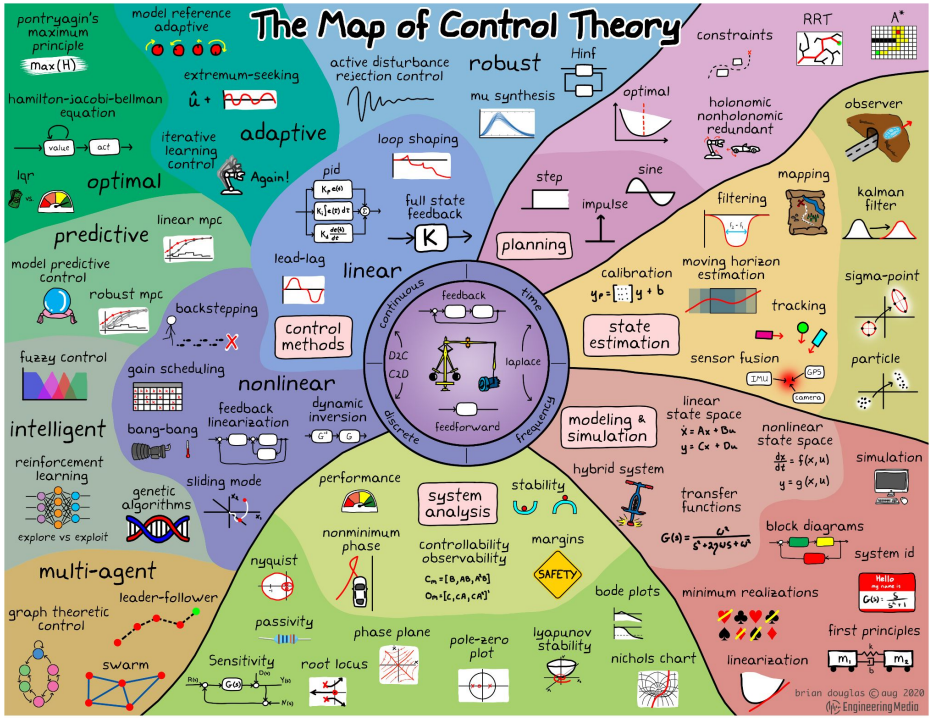
- Decision making refers to finding the optimal choice for the robot to do given the current situation.
- Lots of math and algorithms are involved (i.e. graph theory, probability).
- A task our team has done in the past was to calculate the optimal route for our drone given a table of possible waypoints to fly too.



Controls

- Control theory is the field that deals with the control of dynamical systems in robotics.
- From perception and decision making we can figure out what the next move is, now how do we put this in action?
- Controls for the drone is a shared project with the embedded flight software team.
- A project related to controls that WARG is working on is IMACS (Integrated Monitoring and Control Station).
  - An in-house built Ground Station.

Controls


The Map of Control Theory
pontryagin's maximum principle
max(H)
model reference adaptive
extremum-seeking
hamilton-jacobi-bellman equation
value
act
iterative learning control
Again!
adaptive
lqr
optimal
predictive
linear mpc
model predictive control
robust mpc
backstepping
fuzzy control
gain scheduling
nonlinear
intelligent
bang-bang
feedback linearization
dynamic inversion
reinforcement learning
explore vs exploit
genetic algorithms
sliding mode
multi-agent
graph theoretic control
leader-follower
swarm
active disturbance rejection control
robust
Hinf
mu synthesis
loop shaping
pid
full state feedback
K
lead-lag
linear
control methods
step
impulse
sine
planning
continuous
discrete
time
frequency
feedback
feedforward
D2C
C2D
laplace
constraints
RRT
A*
optimal
holonomic
nonholonomic
redundant
observer
mapping
filtering
kalman filter
calibration
moving horizon estimation
tracking
sigma-point
state estimation
sensor fusion
IMU
GPS
camera
particle
modeling & simulation
linear state space
nonlinear state space
simulation
hybrid system
transfer functions
block diagrams
system id
system analysis
performance
stability
nonminimum phase
controllability
observability
margins
SAFETY
nyquist
bode plots
minimum realizations
passivity
phase plane
pole-zero plot
lyapunov stability
nichols chart
first principles
Sensitivity
root locus
linearization
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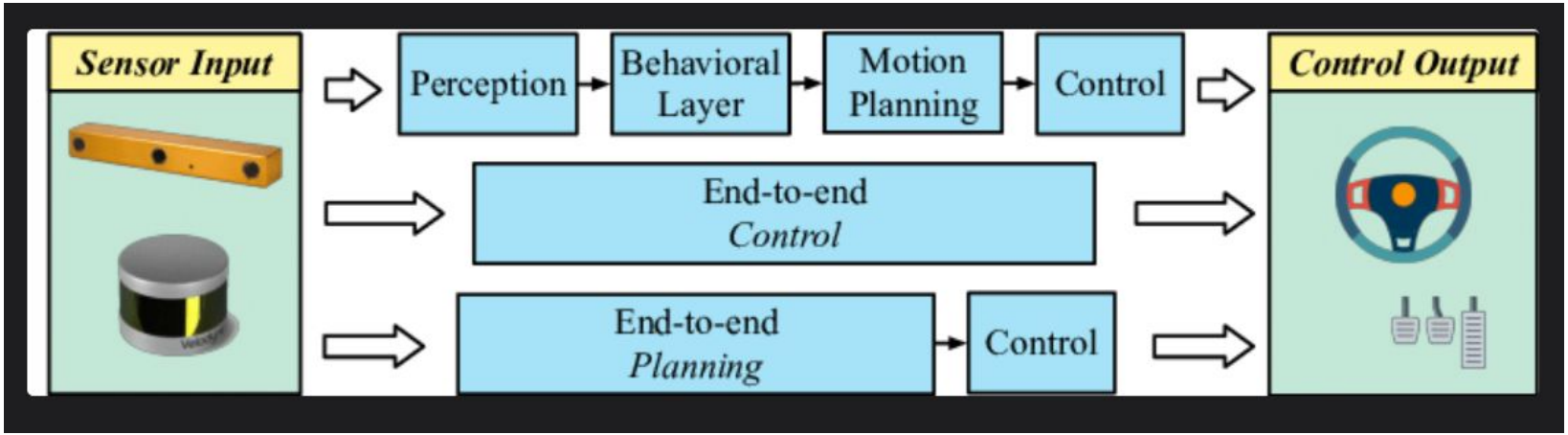
Engineering Media

End-to-End


Sensor Input
Perception
Behavioral Layer
Motion Planning
Control
Control Output
End-to-end Control
End-to-end Planning
Control