Systems Review 1

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- Continuous Time Systems
- Special Case, LTI

A is the dynamics matrix
B is the controls matrix
C is the output matrix
D is the Throughput matrix
x is the state
u is the control
y is the output (what we can measure)

- Linear systems can also be expressed in the LaPlace domain.
- Given the state-space description above, the transfer function form is found by:

- **D** is typically 0 for mech sys.
- For multi-input multi-output (MIMO) systems, $G(s)$ is a matrix of transfer functions.

- For SISO systems, the form is:

- Which corresponds to the ODE:

Simulation diagram for (2)

- We use simulation diagrams to show the relationships of **A,B,C,D,x,u, y** in state space.
- Simulink will integrate the EOM for a sim diag built in a GUI environment by the user.

- These diags are built by forming d**x**/dt according to the state eqn.
- d**x**/dt is the input to an integrator.
- SIMULINK will allow any or all of the signals to be vectors.
- This course focuses on controlling the dynamics of systems like (1), using fuzzy logic & neural networks, or modeling/tuning &/or optimizing such systems using neural nets & GAs.

- Most of the systems we will study are non-linear. However, we choose systems for which we have an intuitive way to control already (cars, robots, etc.) of systems for which an existing controller can be imitated using fuzzy logic or NNs.
- In essence, the methods we study are ways of formalizing human knowledge or imitating human learning / adaptation.

Example: Car

- Although the system is non-linear, and would be difficult to control from a classic standpoint, we realize that most humans easily control the system with no knowledge of the math model above.
- Thus, by appyling existing human knowledge, we can control this system with relative ease!!!

The feedback law:

- More likely we will place our controller in the forward path:

- When *H* is a fuzzy controller, it is very important to determine whether the input equals the output, or an error signal.

- For most simple systems we control in this course, we can use the top picture. However, for complex systems like the Space Shuttle, each control block will be fed a reference trajectory.

The NASA autonomous vehicle Guidance/Control paradigm (Aerospace America, March 2003, p. 41)

- Traj. generation takes current vehicle state & goal & planse the best path to meet the goal.
- Guidance takes the planned path & determines what vehicle attitude (forward speed & steering angle for a car) is required.
- Control takes commanded attitude & moves actuators (throttle, brake, steering wheel) to match guidance commands.
- These 3 blocks may involve AI methods (NNs, FL, GAs).