October 23, 2012

# CISCOR
# Autonomous Ground Vehicle
# Senior Design Group 10

DONALD ALLEX

TYE BUCKLEY

RICHARD KOMIVES

CESAR MIZE

Sponsor: CISCOR

Advisors: Dr. Oscar Chuy
Dr. Emmanuel Collins

# PROJECT NEED

- Currently there is no off road vehicle platform for autonomous research and development in CISCOR's inventory

# PROJECT GOAL

- Modify an existing all terrain vehicle (ATV) to be capable of full autonomous movement by designing, researching and manufacturing components to allow full unmanned locomotion control

# PROJECT OBJECTIVES

- AGV (Autonomous Ground Vehicle) will be able to turn, accelerate, brake and switch gears without physical user interaction
- AGV locomotion controls, mounts and sensors will be durable and able to withstand off road environments
- AGV will retain the ability to be human operated and driven
- AGV will be able to easily mount multiple sensors
- AGV will be able to easily mount multiple onboard computers

# PROJECT CONSTRAINTS

- ATV must retain Autonomous/Human drivability
- AGV must be able to weather off-road conditions
  - Vibration
  - Water and mud
  - Sand and dust
- AGV must be retrofitted with all components in a limited mounting area

# ATV PLATFORM

2012 Polaris Sportsman 550 ESP All Terrain Vehicle

- Liquid-cooled
- Power steering
- On Demand All Wheel Drive (4x2, 4x4)
- 42 Horsepower

# CURRENT ATV Platforms

Carnegie Mellon University

http://www.ri.cmu.edu/


University of North Carolina - Chapel Hill

http://www.unc.edu/


Stanford University

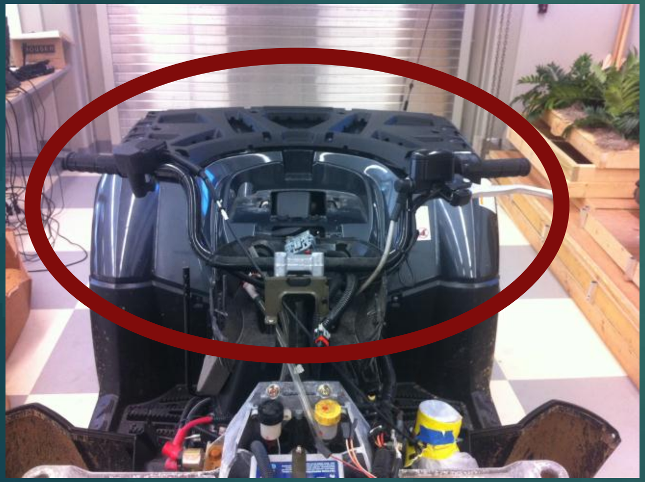
http://cs.stanford.edu/

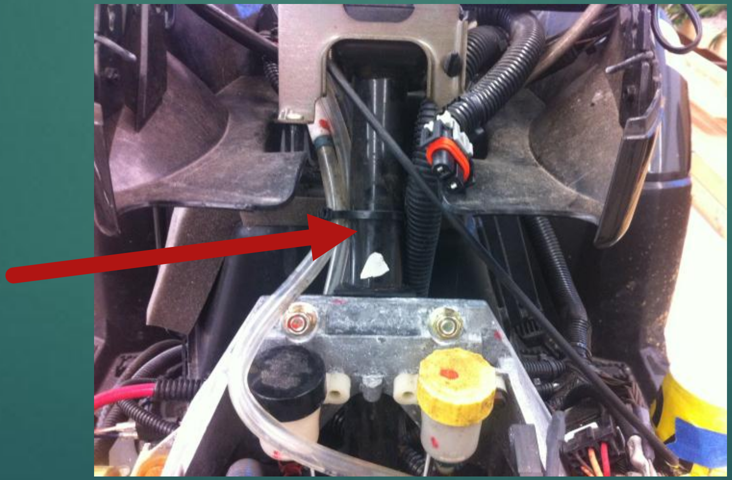
# LOCOMOTION OVERVIEW

- Four main locomotion mechanisms for unmanned ATV movement
  - (1) Steering
  - (2) Braking
  - (3) Shifting
  - (4) Throttle

# STEERING LOCOMOTION

- System will be able to operate with full range of motion
- System will be able to withstand feedback from terrain
- Motor will provide enough output for any terrain and speed

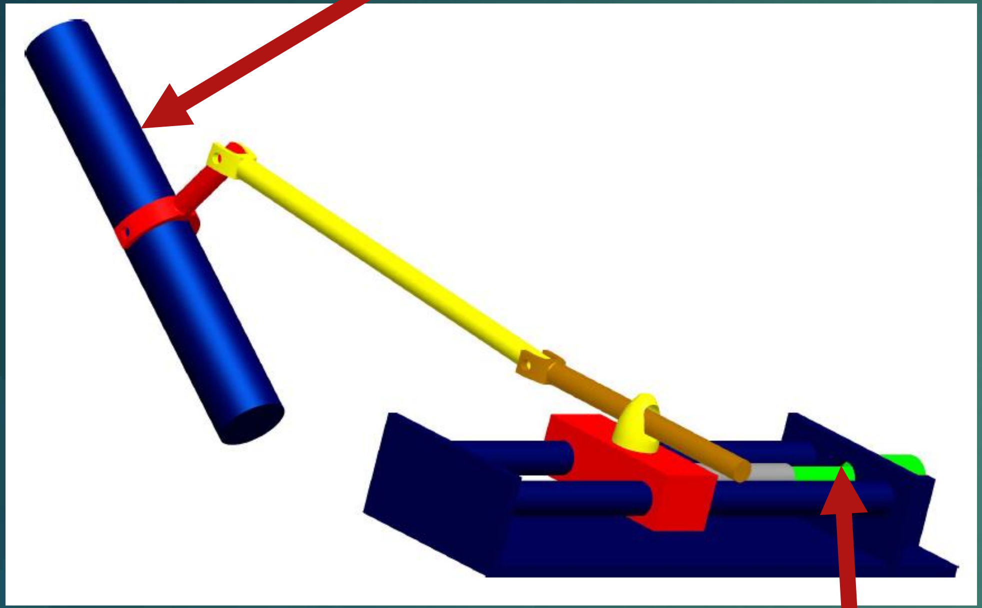




# MEASUREABLE COMPONENTS

- Turning angle of steering column (Degrees)
- Force required to turn steering column on multiple surfaces (Newtons)
- Force of terrain feedback (Newtons)

# DESIGN I STEERING



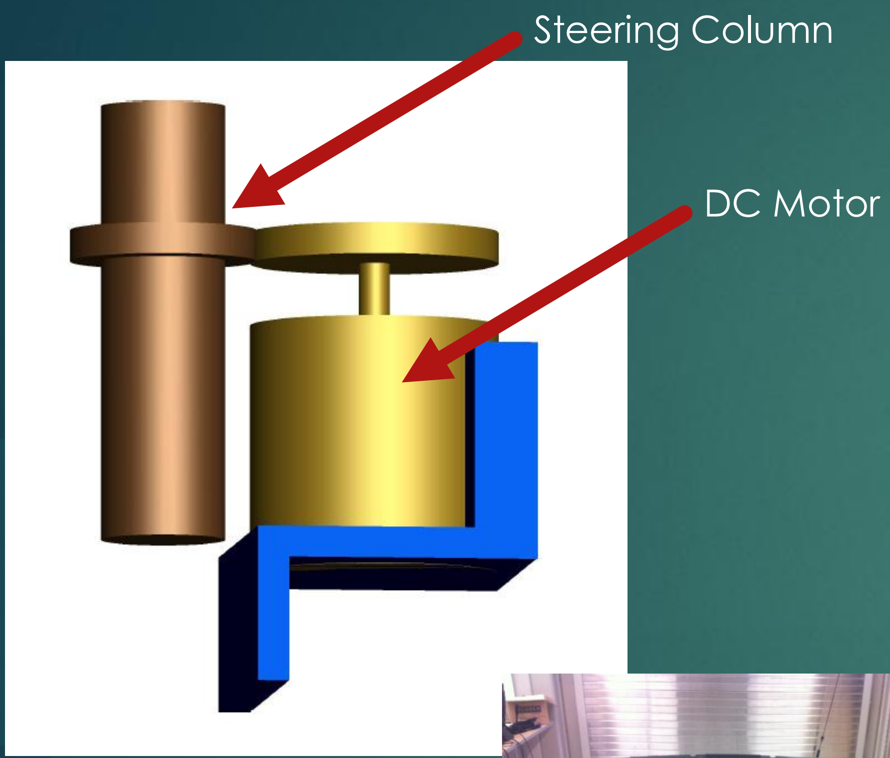

Pros:

- Long moment arm allows for less powerful actuators
- Having two actuators compensates for failure with one
- Pin-jointed shafts allow for system to conform to body shape with no unsightly protrusions
- Pin joints allow for easy disconnect

Cons:

- Multitude of parts yield higher possibility of failure
- Higher cost than other designs
- Pin joints can fail due to debris
- Programming two actuators to work together can be difficult
- Full range of motion hard to achieve

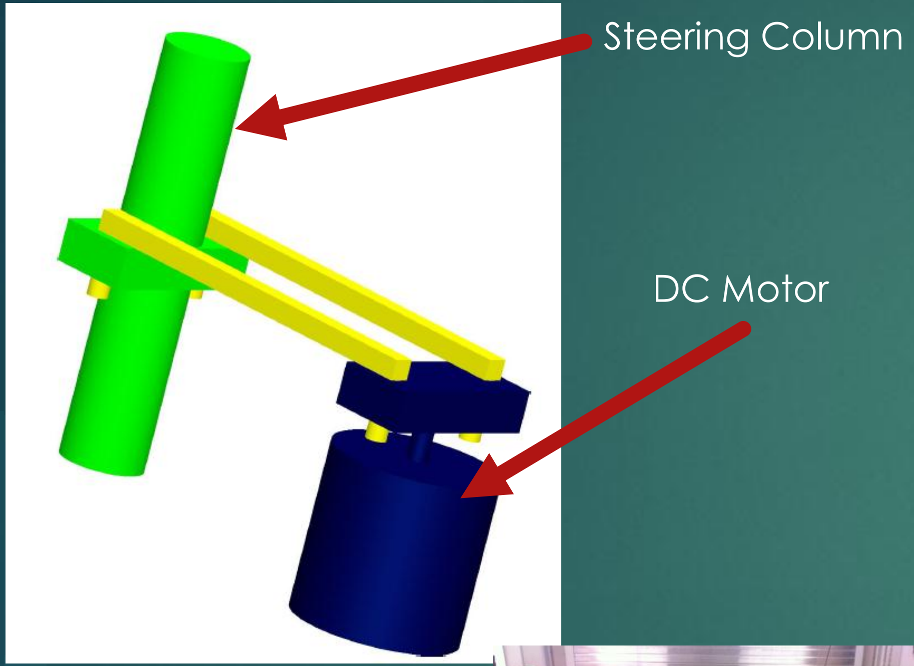
# DESIGN II STEERING




Pros:
- Least amount of space required
- Least amount of parts required
- Lowest cost
- Simplest mounting requirements
- Allows for full range of motion

Cons:
- Small moment arm requires more powerful motor
- Debris can get caught in gears
- Difficult to disconnect

# DESIGN III STEERING




Pros:

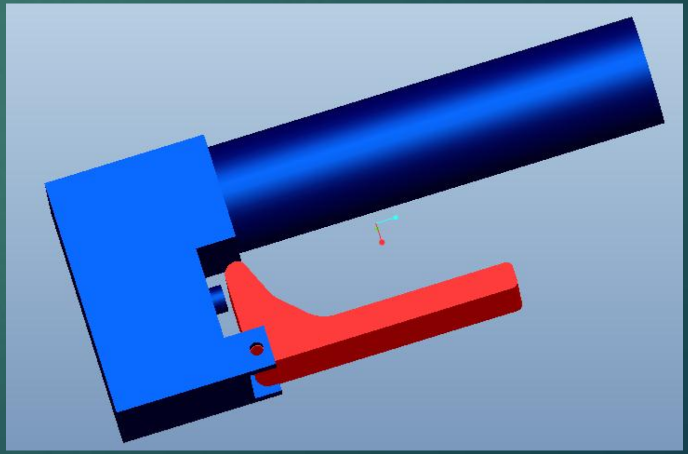
- Larger moment arm requires less powerful motor
- Low cost
- Pin joints allow for easy disconnect

Cons:

- Full range of motion hard to achieve
- Pin joints may fail due to debris
- Long shafts may deflect when encountering feedback from terrain

# BRAKING LOCOMOTION

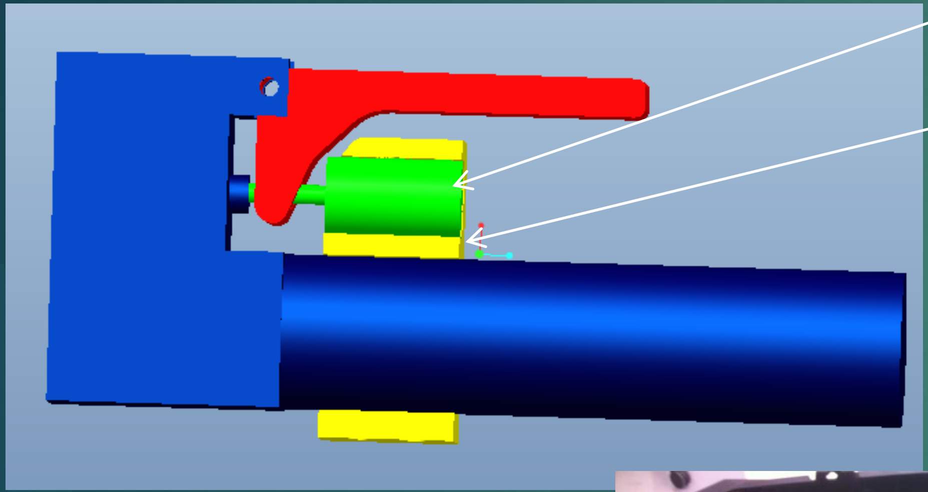
- System will have the same response time for braking as a human would
- System will be able to hold a braking position
- System will be able to utilize full braking range



# MEASURABLE COMPONENTS

- Force required for full braking (Newtons)
- Pump pressure of brake line (Pascal)
- Brake lever travel distance (Millimeters)

# DESIGN I BRAKING



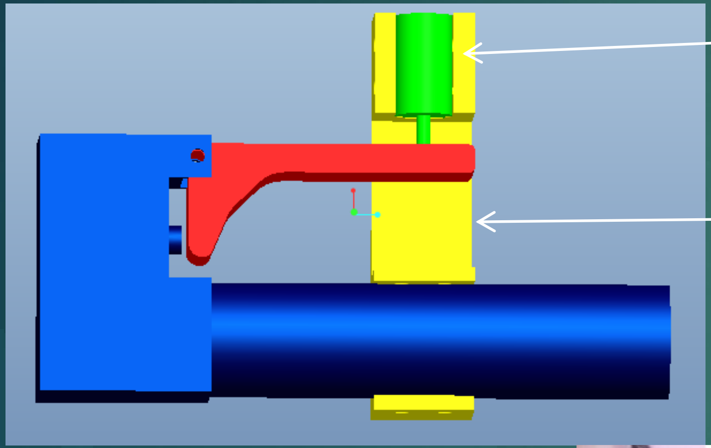

Pros:

- Small modification
- Easy to mount and implement

Cons:

- Requires removal for user operation
- Slow reaction time

# DESIGN II BRAKING



Linear Actuator (green)

Clamp (Yellow)

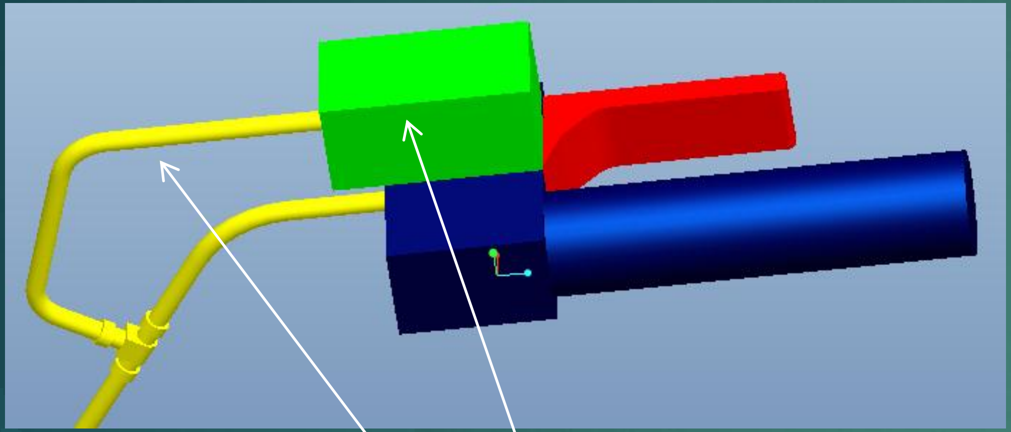
Pros:

- No modification
- Easy to mount and implement

Cons:

- Requires removal for user operation

# DESIGN III BRAKING



Secondary Pump(green)

Parallel Brake Line(Yellow)

Pros:

- Small modification
- Easy to mount
- Does not require removal for manual operation
- Most accurate control

Cons:

- Modification to brake line

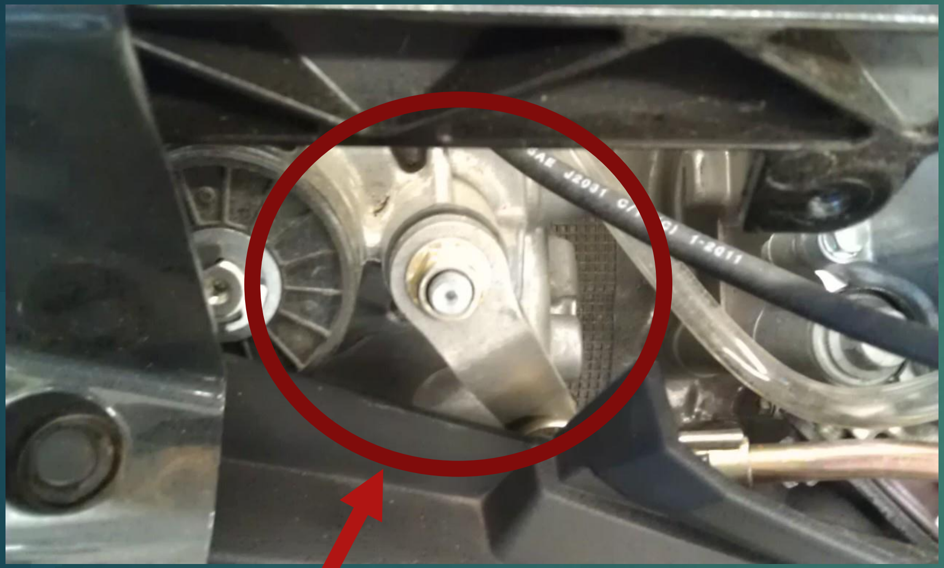
# SHIFTING LOCOMOTION

- System will be able to switch gears precisely
- System will have an actuator with sufficient output to switch gears

# MEASURABLE COMPONENTS

- Force required to move to a different gear (Newtons)
- Total distance traveled by the shifter (Centimeters)

# DESIGN I GEAR SHIFT

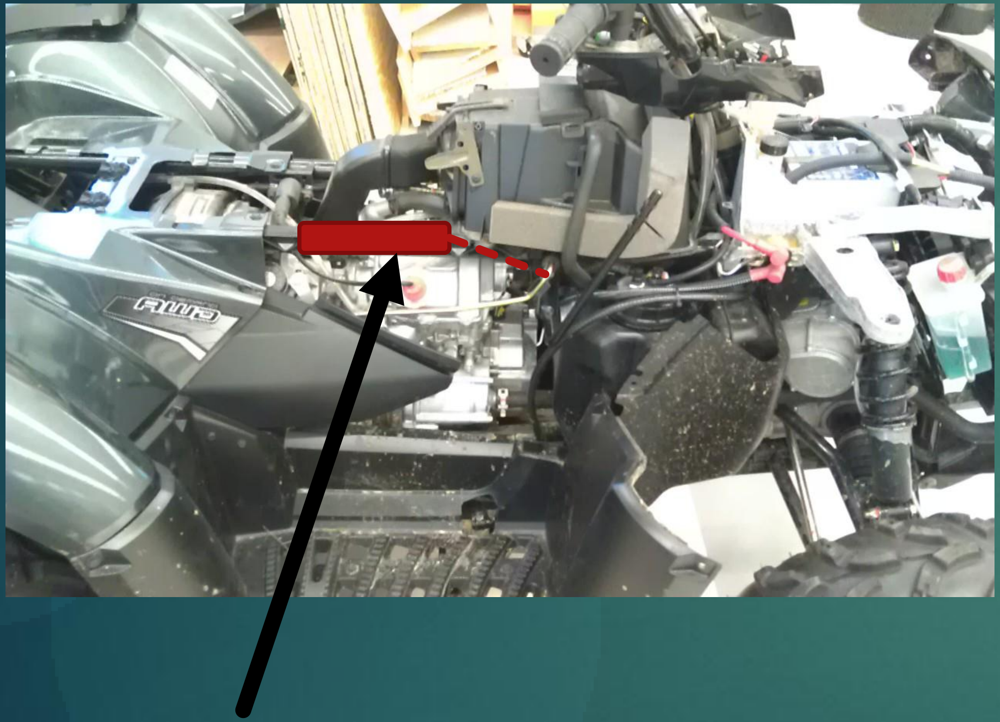


Motor Placement

Pros:
- Simple
- Less moving parts
- Easy to program

Cons:
- Mounting and space limitations
- High torque required
- Costly
- Limited user control

# DESIGN II GEAR SHIFT

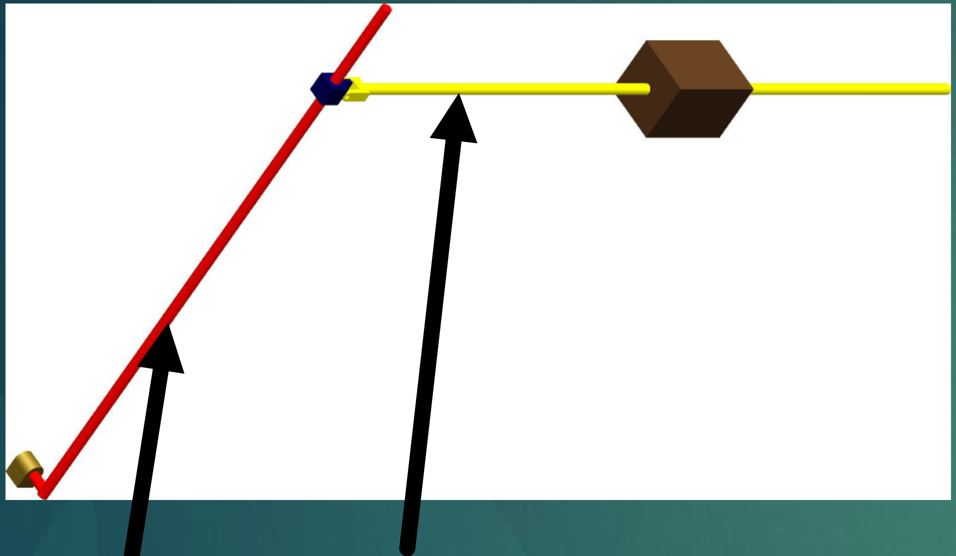


Linear Actuator

Pros:
- Linear actuator
- Easily programmable
- Simple linear motion
- Limited moving parts

Cons:
- Mounting options are limited
- Limits user riding position
- Tedious user operation

# DESIGN III GEAR SHIFT




Pros:

- Simple to mount
- Easy to integrate into computer program
- Back drive ability eliminates disconnecting mechanism

Cons:

- Non-linear mechanism travel
- Arc motion causes lateral forces on the actuator
- Subject to terrain elements

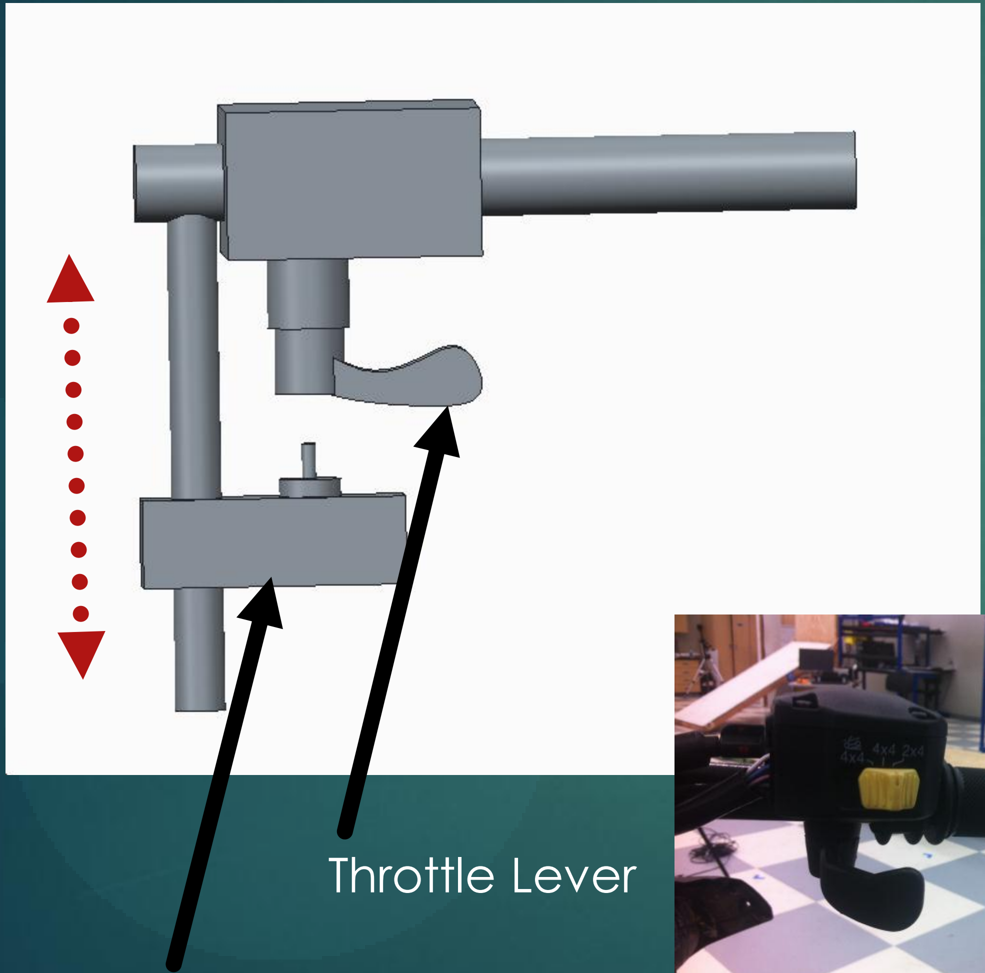
# THROTTLE LOCOMOTION

- System will be precise and responsive
- System will be enclosed to accommodate different elements

# MEASURABLE COMPONENTS

- Force required to turn the throttle lever (Newtons)
- Travel arc of throttle lever (Degrees)

# DESIGN I THROTTLE

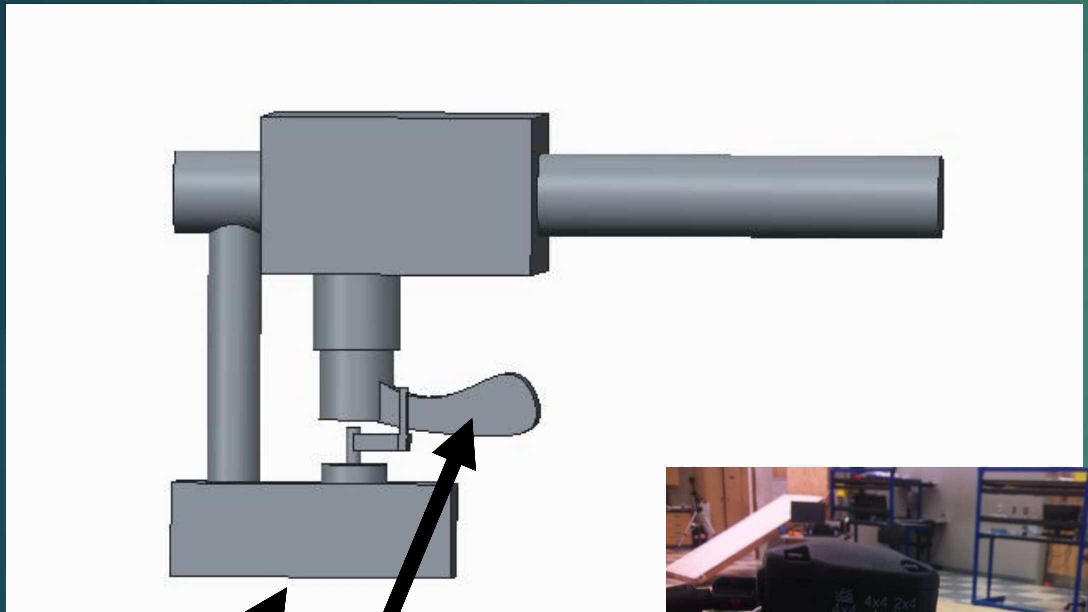



Pros:

- Cheap
- Easy to mount and implement

Cons:
- Requires adjustment for user interaction
- Not enclosed

# DESIGN II THROTTLE




Pros:

- Cheap
- Easy to mount and implement
- Enclosed
- No adjustments for user interaction

Cons:

- More complex design
- More difficult to service

# QUESTIONS?

# WORK CITED


- Hyman, Barry I. *Fundamentals of Engineering Design*. Upper Saddle River, NJ: Prentice Hall/Pearson Education, 2002. Print.
- "Stanford Racing." *Stanford Racing :: Home*. N.p., n.d. Web. 18 Oct. 2012. <http://cs.stanford.edu/group/roadrunner//old/index.html>.
- Tartan Racing Wins Urban Challenge." *Darpa Grand Challenge.com*. N.p., n.d. Web. 18 Oct. 2012. <http://www.darpagrandchallenge.com/>.