AUTOMOTO

SELF-STABILIZING MOTORCYCLE

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MOTIVATION

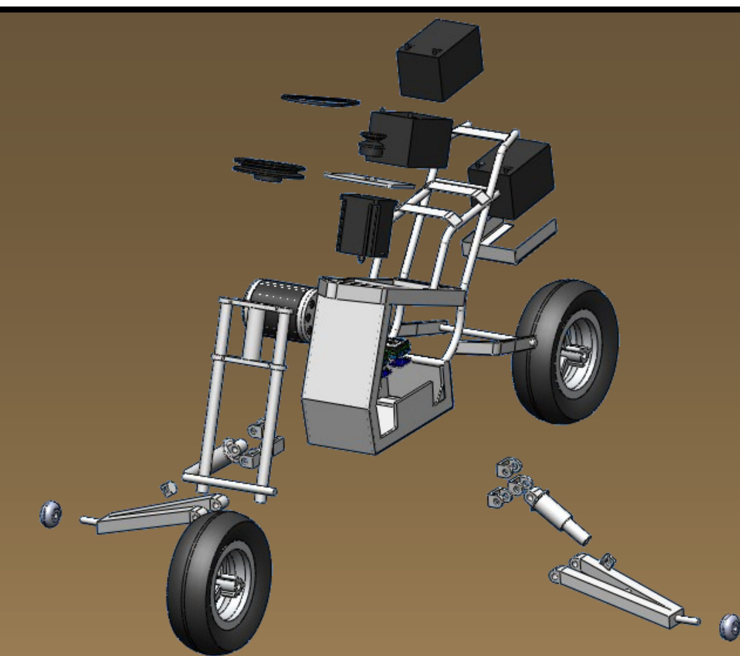
- Study the behavior of motorcycle dynamics and achieve a method for stability for unmanned vehicle control.
- Present sophisticated approach of feedback control theory to further develop an understanding of an autonomous motorcycle.

OBJECTIVES

- Develop current design to perform at desirable stability criterion.
- Add low-speed stability wheels to help prevent rolling instabilities.
- Reprogram microcontrollers for better response of control actuators.

PROTOTYPE DESIGN

- Stepper controlled front wheel provides corrective torque to achieve a stable position.
- Inertial sensor measures lean angles and feedback to microcontrollers.
- Low center of gravity vehicle provides less resistance to corrective torques.
- Actuated stabilizing wheels to help prevent roll disturbances at low speeds.



EXPLODED VIEW OF PROTOTYPE

MATHEMATICAL MODEL

- Expression of motorcycle roll angle and applied torque is

$$mh^2\ddot{\varphi} + \frac{mahVg}{V^2\sin\lambda - bg\sin\lambda}\dot{\varphi} + \frac{mg^2(bh\cos\lambda - ac\sin\lambda)}{V^2\sin\lambda - bg\sin\lambda}\varphi$$

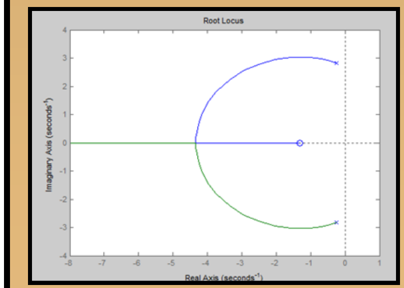
$$= \frac{hVb}{c(V^2\sin\lambda - bg\sin\lambda)}\dot{T} + \frac{b(V^2h - acg)}{ac(V^2\sin\lambda - bg\sin\lambda)}T$$

- Analysis shows that the motorcycle will stabilize at a velocity with zero roll and zero torque (velocity at which stabilizing wheels will ascend).

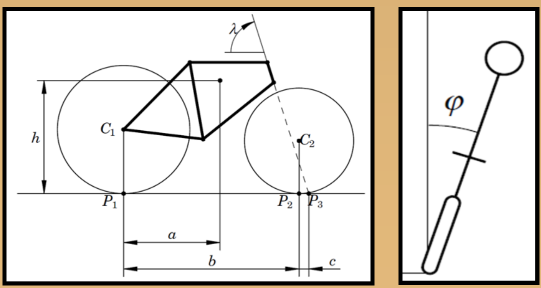
$$V_c = \sqrt{bg\cot\lambda} = 2.02\ \text{m/s}$$

- A second order model was derived to represent the transfer function of the vehicle's roll angle to the applied torque traveling at 5 m/s.

$$\frac{\varphi(s)}{T(s)} = P(s) = \frac{0.8421s + 12.7}{1.468s^2 + 6.905s + 12.07}$$

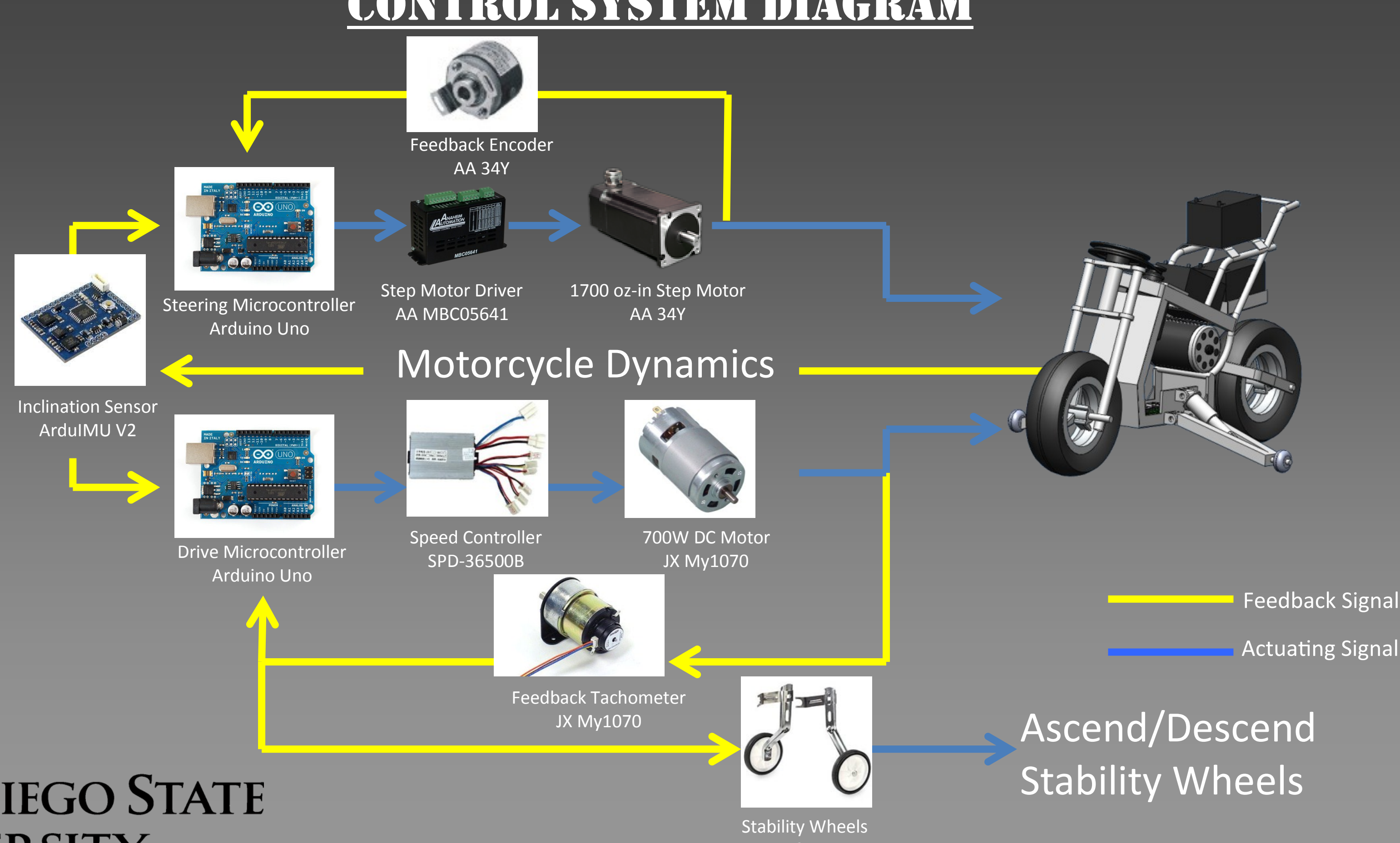


ROOT LOCUS PLOT OF P(S)



SIDE AND REAR VIEW DIMENSIONS

CONTROL SYSTEM DIAGRAM



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