AEACUS: ANT-LIKE ROBOTIC PLATFORM

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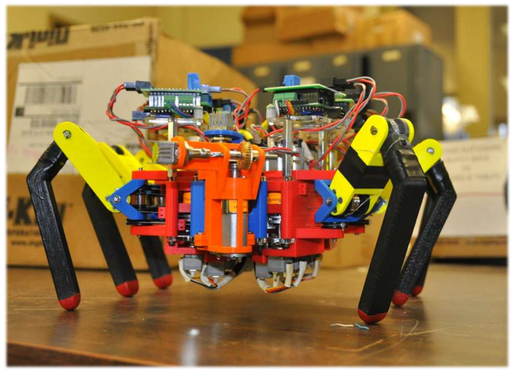
ABSTRACT

A large volume of recyclable material is continually placed in landfills, despite modern recycling efforts. In order to create an effective way of recovering such material, we have designed and manufactured an ant-like robot with the potential to do so. The robot is equipped with the capacity to navigate through the uneven terrain of a trash heap with the ability to lift objects greater than its own weight. The robot is also designed with the intent of becoming part of a swarm to more effectively work over a large area, mimicking an ant colony.

PROJECT GOALS

Design a hexapod robotic platform capable of high mobility and a full range of motion, equipped with the ability to lift and move objects up to twice the robot's weight



Completed Robot

BACKGROUND

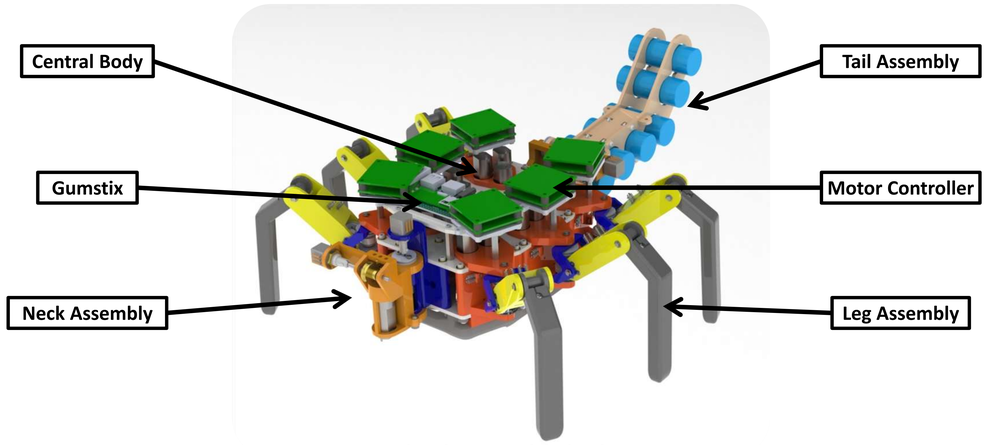
- Ant localization for developing "home" vector
- Cooperative action to perform tasks such as large object lifting or gap bridging
- Swarm interaction for optimal item recovery
- Path following and optimization via pheromone secretion
- Gait synthesis to accurately mimic natural movement
- Indirect leg joint actuation for increased agility

DESIGN SPECIFICATIONS

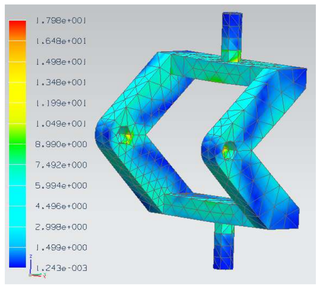
- Biologically-inspired ant design
- Six legs, 3 DoF per leg
- Weight: ~6 lbs
- Lifting capacity: 2 times body weight
- Operational Life: 30-45 minutes
- Body size: 15 inches long
- Speed: 2 body lengths per second
- Basic swarm capabilities

MECHANICAL DESIGN

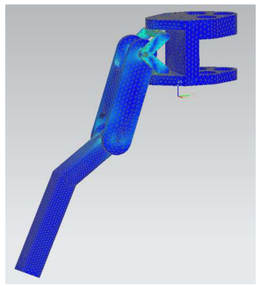
- Separated into four, modular subsystems allowing for easy assembly, disassembly, repair and modification:
  1. Pulley-driven legs to reduce weight, reduce power consumption and increase payload
  2. Two degree of freedom neck for object manipulation and mounting sensory system
  3. Movable tail for use as a counterbalance when holding a payload
  4. Central body to connect subsystems and house electronics



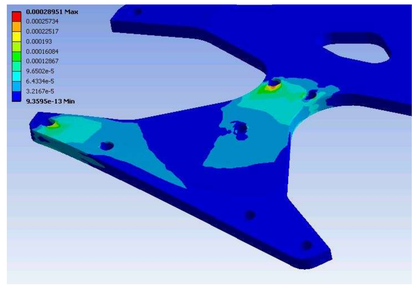
Rendered CAD Model of Robot



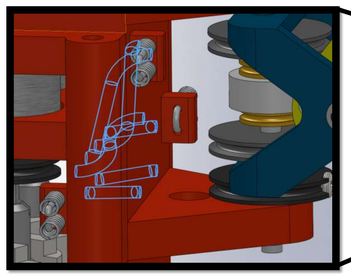
FEA Analysis of Shoulder Joint



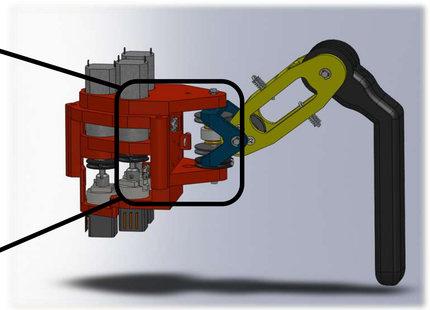
FEA Analysis of Leg Assembly



FEA Analysis of Body Plate



CAD Model of Pulley Guidance Tubes



CAD Model of Leg Assembly

KINEMATICS AND GAIT SYNTHESIS

- Different gaits for varying terrain and goals
  - Tripod gait: three legs moving at a time for maximum speed
  - Wave gait: one to two legs moving balances speed and stability
  - Non-periodic: legs moved individually for maximum stability in tough terrain
- Gait controller computes necessary joint positions and velocities
  - Simplifies input parameters to direction and speed
  - Control body orientation and ground clearance

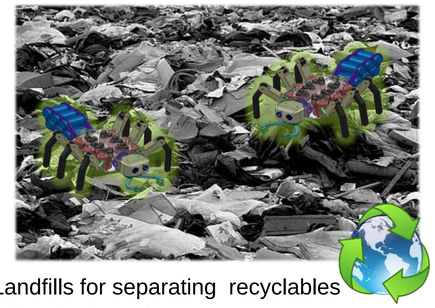
CONTROL ARCHITECTURE

- Master controller: Gumstix Overo FE COM
  - High-level motion computations
  - Texas Instruments OMAP3530: ARM Cortex-A8
  - Onboard DSP and GPU
  - 802.11bg WiFi, Bluetooth
- Slave leg controllers: Custom Design
  - Microchip PIC18F26K22
  - 3 independent H-bridge motor drivers
  - Current and position feedback
  - Used to lighten the computational load on and reduce the number of inputs to the main controller
- Controllers communicate over RS-485 bus

Gumstix Overo FE COM

Custom Motor Controller

MARKETABILITY



- Landfills for separating recyclables
- Cities for litter clean up
- Cheap, disposable units to be used in large swarms
- Rapid deployment into uneven terrain
- Search and rescue
- Cooperative payload transportation
- Mobile sensor network deployment for disaster relief
- IED removal from remote locations
- National Park / beach cleanup

FUTURE DEVELOPMENTS

- Lighter, stronger molded plastic parts
- Development of artificial pheromone system using IR sensitive fluid
- Custom battery pack and power management unit
- Automatic load balancing and tail control
- Compliance in lower leg to improve foot placement