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Robots Human Systems

Session Moderator: Santosh Devasia, Mechanical Engineering

MGH 248

12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

Human-Swarm Interface Design

Karli Justine Berger, Senior, Mechanical Engineering: Mechatronics
Mentor: Anuj Tiwari, Mechanical Engineering, UW Seattle
Mentor: Santosh Devasia, Mechanical Engineering

This project deals with human robot-network collaboration for synchronization to desired reference velocities. A human interacts with the network of mobile robots by sending virtual source inputs to the leading robot. The information propagates through the network from each robot sensing its nearest neighbor. This research proposes a visual interface design to develop a real time, wireless communication channel between a human operator and the robot-network. The model developed introduces real time feedback from the human operator via a graphical interface of the relative positions of each robot in the network. The human operator's ability to move the network cohesively with desired velocity trajectories require rapid information transfer, which is achieved using a delayed self-reinforcement (DSR) technique. We expect the human operator's ability to move the network cohesively to improve with DSR hence enabling easier operation for the operator. The human-swarm interface designed has applications for semi-autonomous networks such as vehicle platoons. We can improve modern freight transportation safety and efficiency with a human remotely operating a robot-network of trucks.

Assistive Feeding Using Fingertip Tactile Sensors with Rich Haptic Feedback

Connor Geiman, Senior, Mechanical Engineering
Mentor: Siddhartha Srinivasa, CSE
Mentor: Hanjun Song, Computer Science and Engineering, Paul G. Allen Center

The ability to eat our meals how and when we want is often taken for granted, but is not a reality for some with limited upper body mobility. Current haptic sensory inputs for autonomous robotic feeding systems are inconvenient and expensive. We propose using GelSight, a fingertip tactile sensor capable of providing rich haptic feedback. Built with silicone and 3D printed parts, GelSight uses a camera to track a grid of dots embedded in the silicone and estimate forces. GelSight is accurate and inexpensive to manufacture and overcomes many of the limitations of currently available and previously tested options. Based on laboratory tests and feedback from potential users we continue to improve our hardware and software, seeking to generalize our solution to any food.

Mathematical Modeling and Design of a Robot Prototype

Abdulrahman (Abdu) Ghalib, Sophomore, Mechanical Engineering, AeroSpace Engineering, Lake Wash Tech Coll
Samuel (Sam) Wolf, Sophomore, Computer Science , Mathematics , Lake Wash Tech Coll
Geoffrey Powell Isom, Junior, Computer Engineering (Bothell)
Mentor: Narayani Choudhury, School of Science, Technology and Math, Lake Washington Institute of Technology, Kirkland

Robotics combines machining and artificial intelligence to create real world humanoid models for task automation and industrial applications. We have designed an in-house robot prototype having microprocessor controlled motion. The robot has lasers for eyes and has a position sensor with camera attached. We designed the gear box, track assembly and robot parts and have written software to control the motion of the robot. The robot is good model for Roomba like vacuum cleaner. We create random walls using Monte Carlo simulations and used vector directed motion to control its motion for avoiding these random walls that the robot encounters to simulate real world experience. We have also studied robotic arm kinematics, using matrix algebra and trigonometry to help design a robot arm that we can rotate or translate to any point in three -dimensional space. We study both forward and reverse kinematics and have written software for the arm motion. Our studies provide an elegant educational platform for studies of robot motion along with simulating real-world experience.

Hopping and Grabbing Insect-Inspired Robot for Space Exploration

Cat Hannahs, Junior, Aeronautics & Astronautics
Maxx Naoyuki (Maxx) Yamasaki, Senior, Extended Pre-Major
Mentor: Sawyer Fuller, Mechanical Eng

Small insect-inspired robots have much potential in exploration and have been experiencing a wave of innovation in recent years. Small robots have promise especially in space exploration where each kilogram costs $10,000 to launch, but tiny robots tend to weigh under a gram. However, some problems persist, such as difficulty with landing after flight and hopping mechanisms wearing down after a few uses. Our work focuses on developing a hopping robot that is capable of attaching to an overhanging surface when it jumps and that has durable mechanisms to optimize the number of jumps per bot. The hooking mechanism differs from previous work, usually electrostatic patches, and instead is inspired by the hooked feet of beetles, which is lighter and does not require constant electrical power. For optimizing jumps, we are working to develop a jumping body constructed from and designed for carbon fiber rather than the previously used fiberglass. Carbon fiber has a higher strength to weight ratio and is more elastic than fiberglass, making it efficient for flight and the repetitive motion carried out by the body when bent by the onboard actuator. All designs are created using an iterative design process where parts are micromachined and assembled, then tested for desired qualities. From this, we are aiming to develop an autonomous hopper capable of completing multiple jumps and grabbing without maintenance on any part of the bot.

A Haptic Mixed Reality Device to Probe Motor Integration in Tethered Moths

Clara Orndorff, Senior, Mechanical Engineering
Mary Gates Scholar
Mentor: Tom Libby

This project aims to influence the next generation of flying robots by first studying how moths use multi-sensory information to increase their agility. These different types of multi-sensory information include visual- and touch-based feedback, which are influenced by forces such as those from flapping wings and changes in body posture (which affect a moth's inertial distribution). In addition, flying insects are known to control orientation via torques arising from at least three distinct affordances: by varying aerodynamic center of pressure, by changing body posture to alter center of mass location, and by swinging body segments or limbs to harness inertial torques. We hypothesize that these sources of control are integrated in parallel to increase robustness and agility, are weighted according to behavioral context, and are tuned to body morphological parameters. To investigate this flight behavior, we first built a test apparatus to apply rapid pitch movements to a tethered flying moth, *Manduca sexta*, while having a minimal effect on a moth's inertia and natural flight patterns. This system allows us to measure the torque exerted by the moth's flight forces and body movement. Closing the loop between measured torque and applied movement enables control of the forces experienced by the moth. Projected video is used to simulate a changing environment and create a haptic-type interface for the moths. The video can provide a visual experience to either match the mechanosensory experience or provide sensory conflict (i.e. a mixed reality environment). The next engineering challenge is to design and build a system to electronically control and monitor the motion of the moth. After this, cameras and sensors will be used to record data that will contribute to a more realistic understanding of how the principles of animal flight can be used in robotics.