Online Proceedings

Poster Session 1

Commons East, Easel 44

11:00 AM to 12:30 PM

Quadrotor Flight with On-Board Autonomous Controlling

Francesca Theresa (Francesca) Liburdy, Junior, Extended Pre-Engineering
NASA Space Grant Scholar
Mentor: Kristi Morgansen, Aeronautics & Astronautics
Mentor: Brian Hinson, Aeronautics & Astronautics

A quadrotor is a small air vehicle propelled by four rotors, or propellers. It is capable of vertical flight, as well as hovering and smoothly changing direction. The quadrotor is more versatile than a fixed-wing air vehicle, as it can move through environments that would limit a larger and less maneuverable vehicle. This research aims to create a successful autonomous computer-based controlling system for a quadrotor's flight. By implementing this technology, the quadrotor could move freely in environments unsafe for human flight controllers. Researchers developed and executed experiments to determine vehicle properties to improve control safety and robustness. In order to create a flight control system that will successfully maneuver the quadrotor without the use of a remote control, the quadrotor's inertia and thrust properties were ascertained. With the inertia and thrust data, controlling the quadrotor with high precision will be possible. The quadrotor's inertia was determined by measuring its rotational period using a photogate timing mechanism and a flashlight beam. Its inertia was found on three principal axes: x, y, and z. A thrust curve was determined for the quadrotor by measuring the thrust produced at each throttle setting using a force transducer. The resulting inertia and thrust properties allow for a deeper analysis of the quadrotor's abilities. In addition, an optic flow sensor will contribute to the quadrotor's flight capabilities. The sensor was calibrated and code was implemented to create communication between the sensor and a computer. When attached to the quadrotor, the sensor rapidly photographs the quadrotor's surroundings, detecting changes in altitude, rotation, and velocity. The optic flow sensor will help stabilize the quadrotor's position and allow it to maneuver away from objects in its flight path.

Poster Session 1

Commons East, Easel 52

11:00 AM to 12:30 PM

Comparison of Detonation Gun for the Ram Accelerator Performance to Development Theory

Sergio Luis (Sergio) Marquez, Senior, Aeronautics & Astronautics
Mentor: Carl Knowlen, Aeronautics & Astronautics

The 38mm bore ram accelerator at the University of Washington has traditionally used a light gas gun to accelerate the projectile to a desired speed before it enters the test section. The light gas gun uses helium pressurized to 6000 psi. This method is expensive, time consuming and the high pressures require the use of a specialized compressor. A new launch gun concept has been developed which uses a shock-induced ignition of hydrogen-oxygen mixtures to produce pressurized steam which is then used to launch the projectile. This new launch system produces the same or better results (i.e. muzzle velocity) as the light gas gun while being easier to operate as well as more time and energy efficient since large quantities of helium are no longer required. Performance data obtained experimentally will be compared to theoretical calculations to validate the theory used to develop the gun.

Poster Session 3

Commons East, Easel 58

2:30 PM to 4:00 PM

How Persistent Vortices along a Kelvin-Stuart Cat's Eye Separatrix Shaped Upper Half Affect Flight Characteristics of a Wing

Nicholas James (Nick) Harvey, Junior, Pre Engineering
Jacob Lloyd Hamilton, Sophomore, Pre Engineering
Mentor: Robert Breidenthal, Aeronautics & Astronautics

The lift-to-drag ratio (L/D) of a wing or propeller is the most important measure of its performance, as a higher ratio defines more efficient designs. The goal of my group's project is to show that sufficiently strong and persistent vortices along the top of a wing will positively benefit its aerodynamic efficiency. Previous results in the UW Fluid Dynamics Lab show that a wavy wall modeled after the Kelvin-Stuart Separatrix shape - which intends to more accurately outline the vortice's flow - further minimize boundary layer turbulence compared to previous wavy wall shapes. We believe that modeling the upper half of our wing along the Kevlin-Stuart Separatrix will keep the boundary layer attached even at very high angles of attack, with relatively low drag coefficients. Two model wings are being tested in the wind tunnel, a control wing with a familiar smooth top half and our experimental model outfitted with vortex generators and the top half shaped to match the Kelvin-Stuart separatrix. Further research may include attaching surface tufts to both models, which qualitatively aid in visualizing flow. The models are mounted to a force balance system, which returns the lift and drag. Our experiments test various angles of attack and vortex generator configurations to compare the wings in different situations, such as take-off and cruise. Achieving the desired L/D will have broad implications for both wing and wind turbine propeller design. More efficient wings could drastically lower fuel costs for airliners, and more effective wind turbines would return more energy at lower cost.

POSTER SESSION 4

Commons East, Easel 55

4:15 PM to 5:45 PM

Computational Design and Analysis of ZaP-HD

Harrison Cole (Harrison) Stankey, Sophomore, Aeronautics & Astronautics

NASA Space Grant Scholar

Mentor: Uri Shumlak, Aeronautics & Astronautics

The ZaP Flow Z-Pinch Project researches the stabilizing effects of sheared axial flow on Z-pinch plasmas. Stable plasmas are necessary to harness nuclear fusion. Nuclear fusion is an essentially limitless source of power, but the difficulty of creating long-lived plasma stability has hindered the development of controlled nuclear fusion. The ZaP experiment forms a Z-pinch plasma by ionizing hydrogen gas into plasma and dynamically forming a 100 cm long column approximately 1 cm in radius. Z-pinches are extremely susceptible to instabilities, which tend to disrupt the plasma on the order of 10-8 s. With a sheared flow, the ZaP experiment has observed a Z-pinch plasma lifetime of 10-5 s. These successful research results have led to a new experiment, ZaP-HD, the goal of which is to produce and observe high energy-density plasma pinches. This new experiment will be modeled with MACH2, a two-dimensional magnetohydrodynamic equation-based simulation code. The design that is modeled will use a similar design to the current ZaP Flow Z-Pinch experiment, however it will have significant modifications to its geometry and operating conditions. These will be reflected in the simulation by changes to the code's input file, which consists of a matrix of points to form the geometry and parameters that determine the running conditions. Two major design changes include the addition of a third electrode and a second power supply. These modifications allow for independent control of the motion of the plasma through the two phases of the experiment. The simulation data collected will provide the team with a complex and detailed view of how this new experiment, ZaP-HD, will operate as well as any changes that need to be made to the planned design.