EET-1195: UNMANNED AERIAL VEHICLES

Cuyahoga Community College

Viewing: EET-1195 : Unmanned Aerial Vehicles

Board of Trustees:
March 2023

Academic Term:
Fall 2023

Subject Code
EET - Electrical/Electronic Engineer

Course Number:
1195

Title:
Unmanned Aerial Vehicles

Catalog Description:
Addresses the emerging market for unmanned aerial vehicle (drones), their ethical use, safety issues, legal issues, electrical and mechanical components, on-board control systems, software and remote control.

HOLD IN QUEUE for Help Ticket on why Bridge doesn't recognize division.

Credit Hour(s):
3

Lecture Hour(s):
2

Lab Hour(s):
2

Requisites

Prerequisite and Corequisite
EET-1100 Introduction to Robotics or EET-1150 Basic Robotics with Math or departmental approval.

Outcomes

Course Outcome(s):
Describe the ethical issues surrounding the use of Unmanned Aerial Vehicles (UAV) and the new uses that affordable UAVs may offer.

Objective(s):
1. Explain possible uses for UAVs in warfare.
2. Explain possible uses for UAVs in police work.
3. Explain the possible uses and ramifications for the use of UAVs in criminal activities.
4. List some industries or services that may be adversely affected (go out of business) because of the expanded use of UAVs.
5. Explain some dangers that public use of UAVs may pose and how quality of life may be enhanced.
6. Explain what "emerging market(s)" means and how UAVs may be viewed as an emerging market.
7. Explain and justify the use of UAVs in spying, including paparazzi.

Course Outcome(s):
Write a formal lab report.

Objective(s):
1. Demonstrate word processing skills by importing pictures, graphs, and schematic diagrams to written lab reports.
2. Verify by using the word processor's statistical rating tool that the report is equal to or above 12th grade (high school) level.

Course Outcome(s):

Demonstrate through programming the operation of a servo control unit that can be used in surveillance.

Objective(s):

1. Determine the range of the camera-fed transceiver that will link a UAV with the control center.
2. Explain the operation of a servo control motor with regard to the x- and y-axis.
3. Test a wireless surveillance camera.
4. Mount a wireless surveillance camera to a gimbal and then mount the gimbal to a servo control unit.
5. Test the gimbal mounted camera and servo assembly and, if operational, mount on a UAV.
6. Test the surveillance camera and servo controller by test flying the UAV and monitor the results at the control center.

Course Outcome(s):

Present an oral report on a lab experiment of your choice.

Objective(s):

1. Verify by using the word processor's statistical rating tool that the report is equal to or above 12th grade (high school) level.
2. Demonstrate presentation software skills by importing pictures, graphs, schematic diagrams into materials to be used in an oral presentation.

Course Outcome(s):

Calculate and explain the forces related to propellers and the wind loading aspects of a UAV.

Objective(s):

1. Explain drag and how it can affect a UAV.
2. Determine the energy in wind relative to a stationary point and explain the mathematical relationship between wind speed and energy.
3. Explain how an airfoil provides lift.
4. Explain how a propeller generates thrust (or lift) and how propeller pitch affects performance.

Course Outcome(s):

Calculate torque, power, efficiency, etc. for a direct current motor(s) used in UAVs.

Objective(s):

1. Explain the difference between permanent magnet (PM) direct current (DC) motors and DC motors that only use electromagnetic properties.
2. Explain how the number of poles affects the speed and torque of a DC motor.
3. Measure and graph the power, speed, and torque characteristics of a PM DC motor.
4. Explain the advantages and disadvantages of brushed versus brushless DC motors.
5. Explain the political and economic issues associated with rare earth minerals is used in PM motors.

Course Outcome(s):

Design, troubleshoot, and explain the general motor control electronics used in UAVs.

Objective(s):

1. Explain and demonstrate the operation of metal oxide semiconductor Field Effect Transistors (MOSFET), calculate power dissipation relative to the transistor's characteristics, and the gate - source control characteristics.
2. Explain pulse width modulation (PWM) and calculate and measure the DC average voltage, the root-mean-square voltage, and power as they relate to the active percentage time of a PWM voltage.
3. Explain and measure the efficiency of control electronics used in UAVs.

Course Outcome(s):

Connect and verify the operation of electronic sensors in a UAV.

Objective(s):

1. List the sensors a UAV may need in autonomous applications.
2. Explain the data frames provided by a global positioning system (GPS) integrated circuit sensor and demonstrate the decoding and display the sequence on a microcontroller or single board computer.
3. Demonstrate the acceleration versus output voltage or digital stream of an accelerometer integrated circuit.
4. Demonstrate the output voltage or digital stream of a compass integrated circuit.
5. Demonstrate the output voltage or digital stream of a barometric pressure integrated circuit.
6. Demonstrate the output voltage or digital stream of a temperature sensing integrated circuit.

Course Outcome(s):

Describe the programming aspects on a stable control system used in a UAV.

Objective(s):

1. Explain the difference between positive and negative feedback systems and provide an example of each.
2. Explain each component of a proportional - integral -differential (PID) control system.
3. Explain what can happen if a negative feedback control system encounters an environment outside of its designed control range.

Course Outcome(s):

Describe the dangers to the public that expanded use of UAVs present.

Objective(s):

1. List the possible effects of UAVs on commercial and private aircraft.
2. Explain how unintentional radio frequency (RF) radiation can adversely affect government, business enterprise, or private citizens with regard to electronic equipment.
3. Explain how jamming a UAV may constitute a hazard for the public.

Course Outcome(s):

Calculate and explain rechargeable battery chemistries.

Objective(s):

1. Explain the difference between energy density and power density.
2. With regard to a battery's energy rating in milliampere hours, explain how the actual energy availability is affected by the discharge current rate.
3. Explain the difference between nickel metal hydride (NiMH) and lithium-ion (Li-ion) battery technologies that include energy density, power density, voltage characteristics under load, memory effect, disposal issues, and inherent danger if a fully charged battery is short circuited.

Course Outcome(s):

Demonstrate navigational methods using latitude and longitude.

Objective(s):

1. Given latitude and longitude, find a point on a map.
2. Using Google Earth or a similar program, given an address or location, provide the latitude and longitude.
3. Design a flight path around an airport by specifying compass direction in degrees, minutes, and seconds (or decimal minutes) and latitude and longitude of turn points.
4. Program an autonomous UAV or fly by remote control a flight path around some object.

Methods of Evaluation:

A. Tests

B. Quizzes

C. Homework

D. Lab Assignments

E. Programming Assignments

Course Content Outline:

a. Concepts
   i. General uses for UAVs, pro's and con's
      1. UAVs in warfare and police work
      2. UAVs relative to criminal activities
      3. Ownership of airspace
      4. Noise
      5. Danger to aircraft
      6. Negative effect of existing markets
      7. Dangers associated with malfunctions or jamming
   ii. Aerodynamics
      1. Wind loading
      2. Propeller Thrust
      3. Drag
      4. Energy of wind
   iii. Electric Motors and control systems
      1. Permanent versus electromagnetic
      2. Brushless versus brushed motors
      3. Obtaining rare earth minerals
      4. Using electronic switches to control motor speed
      5. Concept of Pulse Width Modulation for motor control
      6. Negative feedback in control systems
      7. Failure of negative feedback control systems
   iv. Navigational methods
      1. Longitude
      2. Latitude
      3. Global Positioning System (GPS)
      4. Autonomous flight
   v. Batteries
      1. Energy density
      2. Power density
      3. Nickel-metal hydride (NiMH) batteries
      4. Lithium ion (Li-ion) batteries
      5. Flight range
   vi. Sensors
      1. GPS sensors
      2. Accelerometers
      3. Temperature
      4. Atmospheric pressure
      5. Compass
      6. Collision avoidance
      7. Cameras and radio links
b. Skills
   i. Using electronic test equipment
   ii. Using mechanical test equipment
   iii. Relating lab results with theoretical calculations
   iv. Manual control of UAVs
c. Ethical considerations
   i. Invasion of privacy
   ii. Stealing information through unauthorized viewing
   iii. Terrorism
d. Safety considerations
   i. Danger to aircraft
   ii. Danger to people
   iii. Danger of mishandling Li-ion Batteries (explosions)

Resources

Jerry LeMieux. *Introduction to Unmanned Systems: Air, Ground, Sea and Space: Technologies and Commercial Applications*. 1st. Edition,. Unmanned Vehicle University Press, 2019.

Kevin Roebuck. *Mobile Robot: High Impact Emerging Technology*. 1st. Edition,. Emereo Publishing, 2020.

Ron Rauf. *Getting the Most Out of Makerspaces to Build Unmanned Aerial Vehicles*. 1st. Edition,. The Rosen Publishing Group, 2021.

Jens Graf. *PID Control: Ziegler-Nichols Tuning.* 1st. Edition,. Sinus Engineering, 2013.

Kimmo Karvinen Tero Karvinen. *Make: Getting Started with Sensors: Measure the World with Electronics, Arduino, and Raspberry Pi.* 1st. Edition,. Maker Meddia, Inc., 2014.

Charles Bell. *Beginning Sensor Networks with Arduino and Raspberry Pi.* 1st. Edition,. Technology in Action, 2015.

Resources Other

Electronic Devices and Circuit Theory (11th Edition),

by Robert L. Boylestad (http://www.amazon.com/Robert-L.-Boylestad/e/B001HCV9ZU/ref=sr_ntt_srch_lnk_1/?qid=1428084669&sr=1-1) and Louis Nashelsky, 2012, 11th Edition

Pearson

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