CIS A160: INTRODUCTION TO UAS AUTOMATION

Item	Value
Curriculum Committee Approval Date	12/08/2021
Top Code	070710 - Computer Programming
Units	4 Total Units
Hours	90 Total Hours (Lecture Hours 63; Lab Hours 27)
Total Outside of Class Hours	0
Course Credit Status	Credit: Degree Applicable (D)
Material Fee	No
Basic Skills	Not Basic Skills (N)
Repeatable	No
Open Entry/Open Exit	No
Grading Policy	Standard Letter (S), • Pass/No Pass (B)

Course Description

This course introduces students to the automation of Unmanned Aircraft Systems (UAS), including UAS flight control, camera and video capturing, telemetry data analysis and mission management. Throughout the semester, students will work in teams to plan, design and automate Unmanned Aircraft System missions by learning and using Software Development Kits (SDKs) of industry leading UAS providers. UAS projects will include behaviors such as path-following, random roaming with obstacle avoidance and telemetry data collection and analysis. Enrollment Limitation: APT A160; students who complete CIS A160 may not enroll in or receive credit for APT A160. ADVISORY: CIS A090, CIS A100, CIS A111, or CS A122. Transfer Credit: CSU.

Course Level Student Learning Outcome(s)

1. Collect in-flight UAS telemetry data and employ the use of software to process, analyze and construct meaningful information for the flight mission.
2. Use UAS automation to solve problems that incorporate the use of mission planning, way points, rally points and on-board navigation systems.

Course Objectives

- 1. Describe the major categories and roles of Unmanned Aircraft Systems (UAS).
- 2. Identify the primary types of sensors used for UAS data collection.
- 3. Use an autopilot software development kit supporting multi-copters, traditional helicopters, fixed wing aircraft and rovers.
- 4. Demonstrate proficiency in using the fundamental automation features of UAS, including waypoints, rally points, events and mission commands.
- 5. Calibrate on-board navigation systems, such as compass, accelerometer and radio control prior to flight mission.
- 6. Safely execute flight mission with intersection of planned rally points and a Return to Launch (RTL) landing.
- 7. Collect flight telemetry data, including geotagged images, video and on-board sensor data.
- 8. Conduct telemetry data analysis using software to provide information about flight mission.

Lecture Content

UAS Fundamentals Terms and Definitions Types and Roles Civilian Tiers Military Tiers Groups Size/Weight Classes Level of Autonomy Licensing and Regulations Maintenance and Logistics Mission Planning Considerations UAS Careers UAS Market - Current and Future Trends Career Paths Technology Update Airspace Integration with other Aircraft Inertial Navigation Systems (INS) Compass Gyroscopes Accelerometers Stabilization Global Positioning System (GPS) Navigation Satellite-Based Navigation Principles Ranging, Fixing and Time Message Breakdown Differential GPS Comparing Accuracy and Availability Sensors Sensor Basics Airspeed Altimeter Temperature G-Force Microcontrollers Mission Planning and Automation Flight Plan Flight Data Waypoints and Events Mission Command List Rally Points Camera Control Auto Missions Swarming Configuration and Calibration Compass Calibration Accelerometer Calibration Radio Control (RC) Calibration RC Transmitter Configuration Telemetry Data Collection and Analysis Camera Data Collection Geotagging Images Video Data Collection Sensor Data Collection Postprocessing In-Flight Data View, Analyze and Play Back Telemetry Logs

Lab Content

Installing Mission Planner Running the installation utility Opening Mission Planner Updating Mission Planner Loading Firmware onto Flight Controller Connecting computer to auto pilot board Connecting to auto pilot board to Mission Planner Testing Firmware Mission Planning Features Flight planning Flight data collection Configuring on-board compass Configuring on-board accelerometer Configuring on-board radio control Mission Automation with Waypoints and Events Produce and save a multi-waypoint mission Load a pre-saved multi-waypoint mission Create default altitudes Plan an auto-grid for mission Mission Command List Navigation commands Command parameters DO commands Condition commands Delay commands Frames of reference Camera Missions Camera commands Camera gimbal commands Servo and relay commands Survey (grid) mission Creating composite images Telemetry Data Analysis Geotagging images Post-processing of video Analyzing flight data Interpreting data to inform flight mission Creating Scripts to Automate Flight Missions Scripting to automate common tasks Returning to Launch (RTL) scripts Aerial maneuvers with scripts Swarming of multiple Unmanned Aerial Vehicles (UAVs)

Method(s) of Instruction

- Lecture (02)
- Lab (04)

Instructional Techniques

Lecture/laboratory

Reading Assignments

Students will spend a minimum of 3 hours per week reading materials assigned, including content online. Students will be expected to follow along with the exercises in the reading material.

Writing Assignments

Students will spend a minimum of 5 hours per week writing code.

Out-of-class Assignments

Students will spend a minimum of 5 hours per week completing weekly UAS assignments or projects.

Demonstration of Critical Thinking

Written quizzes and examinations; weekly UAS projects; in-class UAS assignments; capstone project

Required Writing, Problem Solving, Skills Demonstration

Weekly UAS projects, in-class assignments, quizzes, examinations and capstone project will be evaluated.

Eligible Disciplines

Computer information systems (computer network installation, microcomputer ...: Any bachelor's degree and two years of professional experience, or any associate degree and six years of professional experience.

Textbooks Resources

1. Required McGriffy, D.. Make: Drones: Teach an Arduino to Fly, 1 ed. San Francisco: Maker Media, Inc., 2017 2. Required Marshall, D., Barnhart, R., Shappee, E. Most, M.. Introduction to Unmanned Aircraft Systems, 2 ed. Boca Raton: CRC Press, 2016

Software Resources

1. ArduPilot. ArduPilot, 2.6 ed. ArduPilot is a open source autopilot system supporting multi-copters, traditional helicopters, fixed wing aircraft and rovers. 2. Mission Planner. ArduPilot, 1.3.44 ed. Mission Planner is a ground control station for Planes, Copters and Rovers. Mission Planner can be used as a configuration utility or as a dynamic control supplement for your autonomous vehicle. Currently, Mission Planner is compatible with Windows computers only.