# GIS-550: INTRODUCTION TO SUAS (DRONE) SYSTEMS USE IN REMOTE SENSING

**Effective Term**
Fall 2025

**BOT Approval Date**
10/10/2024

**Discipline**
GIS - Geospatial Information Science
**Course Number**
550

**Course Title**
Introduction to sUAS (Drone) Systems Use in Remote Sensing

**Short Title**
sUAS Remote Sensing

**Credit Status (CB 04)**
D - Credit - Degree applicable

## Units

**Lecture Units**
2.00

**Lab Units**
1.00

**Total Units**
3.00

## Hours

**Lecture Contact Hours**
32-36
**Out of Class Hours Lecture**
64-72

**Lab Contact Hours**
48-54
**Out of Class Hours Lab**
0.00

**Total Contact Hours**
80 - 90

**Total Out of Class Hours**
64 - 72

**Total Student Learning Hours**
144 - 162

**Is this an existing Extensive Lab?**
Yes

**Distance Education**
Yes

## Distance Education

**Distance Education Type**
Hybrid Only

**What will be done in face-to-face meetings**
The face-to-face meetings will be primarily focused on students completing the actual drone flight collection of digital imaging requirements of the laboratory portions of the course.

**Are you using publisher content?**
No

**Regular Substantive Interaction**
Instructor-to-student, student-to-student, and student-to-content contact shall be distributed in a manner that will ensure regular substantive interaction (RSI) is maintained not only weekly but also for the duration of the course. Instructor interactions should be equivalent in time, quality and consistency to the engagement students would receive in a face-to-face course—for example, through announcements, discussion participation, personalized feedback, video messages, or other instructional communications. Instructors are expected to be responsive to student inquiries within a 24-72 hour time frame excluding holidays. RSI will be maintained through a variety of methods: • Orientation - Students must be oriented to the online and face-to-face portions at the start of the course. • Announcements - Announcements using the course management system must be posted at least weekly to keep students current on course events, due dates, materials, etc. • Discussion Forums - Content-related discussion forums within the designated CMS will include appropriate instructor participation and will be initiated and maintained, with timely feedback provided. Instructors are required to monitor the discussions and related activities to provide guidance and direction. Open-ended discussion boards may be used to further learning and interaction. • MSJC Communication – Instructor will use MSJC-administered communication tools (such as email or the designated CMS communication tools) to regularly communicate with and provide ease of access to students. • Timely Feedback - Timely feedback on student work will be provided by the instructor, which may include comments and/or rubrics, within the Grades area of the designated CMS. • Scheduled Meetings – Hybrid and synchronous courses will meet at regularly scheduled times. ADA Compliance - All course interactions and content must be designed with accessibility in mind and meet ADA requirements.

**Catalog Description**
This course introduces students to a basic understanding of the use of sUAS (drones) for remote data collection. It includes presentations of remote sensing theory, and implementation using sUAS platforms, aerial drones, for digital data and imagery collection and the analysis of data for geospatial information science, GIS, applications. Topics include non-aerial, conventional aerial, and satellite imagery collection; however, the major emphasis of the course is imagery and data acquisition, image interpretation, and applications of sUAS (drone) collected imagery and digital data. Students develop skills using different types of sUAS equipped with remote sensing systems and software to produce and analyze remotely collected digital data.

## Requisites

**Recommended Preparation**

| Recommended Preparation (note that students can enroll in the class even if they haven't take the recommended course) |
|---|
| Some experience with sUAS (drone) piloting skills is recommended. These skills can be acquired in many ways other than formal training. Completion of GIS-540 (with a grade of C or better) or an FAA Part 107 License satisfies the recommended preparation but is not required. |

## Codes

**TOP Code (CB 03)**
2206.10* - *Geographic Information Systems

**CIP Code**
45.0702 - Geographic Information Science and Cartography.

**Repeatability Code**
No

**Grading Option**
Letter grade OR P/NP

## Learning Objectives

**Learning Objectives**

| Learning Objective |
|---|
| 1. Evaluate digital imaging post-processing techniques to obtain the desired geospatial information outcomes. |
| 2. Appraise aspects of using drone acquired imagery to evaluate geospatial distributions of human populations as it pertains to race, gender identity, sexual orientation, and cultural differences. |
| 3. Acquire, and validate digital images from drones. |
| 4. Differentiate between and evaluate the effectiveness of a variety of sUAS platforms for the collection of remote sensing data. |
| 5. Diagnose mapping area environmental concerns and considerations for a remote sensing sUAS flight plan. |
| 6. Evaluate ethical and privacy concerns of remote image gathering about people. |
| 7. Discuss the pros and cons of various sources of remote digital imagery collection. |
| 8. Review the impact of digital media collection on the diversity and distribution of human populations.. |
| 9. Critique the use of a variety of spatial and spectral enhancement in remote sensing applications. |
| 10. Develop and operationalize a drone flight plan for the collection of remote sensing data. |

## Learning Outcome Information

**Course Learning Outcomes**

| Learning Outcome |
|---|
| 1. The student will interpret drone collected, remote sensing, geographically referenced data. |
| 2. The student will analyze the capabilities, limitations, and features of drone collected imagery and other digital data.. |
| 3. The student will apply knowledge and skills to collect and process sUAS acquired remote sensing imagery and date with a variety of sensors including GPS, video and/or still photography. |
| 4. The student will design, prepare, and critique examples of drone collected remote sensing imagery. |
| 5. The student will formulate and construct a sUAS flight plan for the collection of remote sensing data. |

**Program Learning Outcomes**

| Learning Outcome |
|---|
| Integrate spatial thinking with applied technology to analyze physical and cultural patterns, and discuss trends and relationships. |
| Explore spatial relationships at different scales from local, regional to global. |
| Explain the interrelationship between humans and the physical environment |
| Apply the scientific method to objective and subjective analysis of cultural and physical environments. |
| Appreciate different cultural and ethnic perspectives within the context of opportunities and challenges. |

**Institutional Learning Outcomes**

Aesthetic Awareness: The student will identify and evaluate how aesthetic expression leads to an appreciation of social and cultural context as well as the values of art and nature.
Critical Thinking: The student will analyze problems, gather and synthesize relevant information, evaluate ideas, information, and evaluate alternative points of view to create, innovate and implement effective solutions.
Cultural Awareness and Humility: The student will demonstrate knowledge of and sensitivity toward individuals of diverse ethnicity, age, gender, sexual orientation, and religious affiliations, as well as toward those individuals with diverse abilities and socio-economic classes to respectfully interact with individuals of diverse perspectives, beliefs and values while being mindful of the limitation of their own cultural frameworks.
Information and Technology Literacy: The student will access, interpret, evaluate, and apply relevant information sources and digital media effectively, and in an ethical and legal manner.
Scientific Awareness: The student will apply the scientific method of inquiry to assess potential solutions for real-life challenges by employing science-based knowledge and methodologies in daily life.

Social Awareness: The student will recognize and analyze the interconnectedness of global, national, and local concerns, analyzing cultural, political, social, and environmental issues from multiple perspectives and appreciate similarities and differences among cultures.
Personal
and Professional Responsibility
Civic

## Content

**Course Lecture Content**

1. Geospatial Information: Introduction to Digital Media
2. Historical Look at Remoting Sensing
3. Use of Digital Media as Geospatial Information
4. Sources of Remote Digital Imagery Collection
   a. Conventional aircraft
   b. Satellite
   c. sUAS (drone) Small Unmanned Aerial Systems
   d. Terrestrial and Underwater
   e. Private, Governmental, Open Resource imagery data
5. 5. Use of sUAS in Collection of Digital Media
6. The Impact of Digital Media On the Diversity and Distribution of Human Populations
   a. Impacts on the Individual
   b. The Pros and Cons of Connectedness
7. The Digital Society
   a. The Necessity of Digital Interaction
   b. Use of Digital Imagery in GIS
   c. Legal and Ethical responsibility
8. Cultural Literacy in Digital Trends
   a. Protests, Opinions, and False Information
   b. Engaging in Digital Conversation
9. Digital Imaging with sUAS
   a. Survey potential capture devices
   b. Checklist
   c. Flight operation and camera operation
   d. First Person View systems
   e. Flight Parameters
   f. Flight times & wireless transmission
   g. Limitations
   h. Way finding
10. Preparation for sUAS Digital Imagery Collection
    a. Basic drone flight preparation
    b. Flight design
    c. Camera preparation
11. Flight restrictions for remote image data collection
    a. Special use airspace
    b. Prohibited airspace
    c. Differentially restricted airspace
12. Post Processing and Delivery
    a. Stabilize video
    b. Panoramic photos
    c. Remove lens distortion
    d. Sharing images

**Course Lab Content**

1. sUAS Digital Imagery Collection and Analysis
   a. Flight planning for data collection
   b. Selection of drone platform

   c. Selection of imagery hardware
   d. Application to commercial product or research
2. Ethical and Privacy Concerns of Remote Image Gathering About People
   a. Geospatial distributions of human populations
   b. Perspective from different ethnic and racial backgrounds
   c. Socio-economic consideration
   d. Sensitivity to gender and gender nonconforming individuals
   e. Differentially abled and special need populations
3. Drone Flight Simulation for Remote Imagery
   a. Development of drone flight plan for imagery collection
   b. Identification of drone and camera platforms
4. Drone Operations for Remote Imagery
   a. Flight duration and area to be covered
   b. Mapping area considerations
   c. Environmental concerns
   d. Human and facilities concerns
   e. Battery life and pilot proximity concerns
5. Digital Collection Equipment
   a. Still or video imagery
   b. Digital non-visual data
   c. Lidar and other specialized imagery
   d. 2D vs 3D
   e. Gimbal capabilities
   f. Multiple format
6. Electromagnetic Radiation Principles of Non-visual Data Capture
   a. Insolation
   b. Radiation
   c. Electromagnetic spectrum
   d. Emitted vs. natural electromagnetic radiation
7. Remote Sensing Platforms and Sensors
   a. Multispectral scanners
   b. Hyperspectral scanners
   c. Infrared and thermal scanners
8. Sensor Modification
   a. High pass filter
   b. Low pass filter
   c. Edge enhancement filter
   d. Directional filter
9. Consideration of Land Use Classification
   a. Supervised classification
   b. Unsupervised classification
10. Temporal Change Detection in Digital Projection
   a. Image differencing
   b. Multi-date visual change detection
11. Introduction to Data Processing Applications
   a. Site Scan
   b. Drone2Map
12. Drone Flight for Data Collection
   a. Demonstration of manual and programmed flight
   b. Execution of flight plans
   c. Logbook entry
   d. Accumulation of flight time (minimum 2 hours)
13. Data Processing and Analysis
   a. Use of image processing applications for remote data collected
   b. Final performance development and execution

## Methods of Instruction

**Method**

Lecture

**Integration**

Lectures explore the professional understandings of the components, equipment, and technology used to set-up a working drone for the collection of digital imagery including aspects of the legal and ethical responsibilities of collection of digital imagery. Lectures help students compare and contrast conventional photographic and video technology to drone application technology as well as giving them an appreciation of the knowledge and skills necessary to participate in drone imagery applications.

**DE Adaptations for MOI**

Lectures are provided in both written and video formats using the CMS (course management system). Lecture instructions and information is provided in the course management system using an accessible formats.

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**Method**

Lab Activities

**Integration**

Students participate in laboratory groups to operate and program a drone equipped with a variety of sensors including GPS, video and/or still photography. Students work as a team of two or more individuals with one person operating the camera and one operating the drone flight. Laboratory activities develop hands-on skills and knowledge for applications of drone collected imagery and other forms of digital data.

**DE Adaptations for MOI**

Student completes assignments individually and in facilitated laboratory groups and submit the assignments using the CMS (course management system). Laboratory activity instructions and information will be in the course management system using an accessible format.

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**Method**

Discussion

**Integration**

Students participate in a discussion of various aspects of drone data collection and analysis as to how it relates to human diversity. Discussion includes aspects of how members of
different social, cultural, racial, ethnic, gender, age characteristics of human population might/can be affected by drone digital data collection and analysis.

**DE Adaptations for MOI**

Discussion session will require students to discuss this material both among themselves and with the instructor. using Discussion protocols within the CMS. Information specific to the analysis of the individual assignments will be available in the course management system using accessible formats where appropriate.

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**Method**

Observation and Demonstration

**Integration**

Students observe, participate and evaluate drone collected digital information as it is used in GIS data recovery applications. These demonstrations guide students through data collection processes, uploading, analysis and applications using sUAS for imagery and spatial analysis. Demonstrations and observation of real-world scenarios focus on drone applications in the collection of digital data, problem-solving methods, and decision-making techniques in imagery endeavors. These observation and demonstration activities help students define and evaluate problems associated with acquisition and accuracy of drone collected imagery and digital data applications.

**DE Adaptations for MOI**

Demonstrations and observation information will be available in the course management system using accessible formats. These assignments may use accessible teleconferencing media or prerecorded videos that focus on various drone collected imagery and digital data applications, problem-solving methods and decision-making techniques. Discussion assignments will be made available using the CMS.

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**Method**

Individualized Instruction

**Integration**

Students work individually with the instructor to develop and demonstrate the ability to operate and program a drone, equipped with a variety of sensors including GPS, video and/or still photography. Instructor works with individual students to collect, prepare and present a portfolio of drone collected digital imagery.

**DE Adaptations for MOI**

Students may participate with the instructor in digitally facilitated instruction, such as ZOOM, individually or in groups. The instructor may facilitate individual asynchronous meetings with students using the CMS. A variety of on-line, asynchronous, opportunities will be made available in the CMS (course management system). Individual work with students will meet accessibility standards.

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## Methods of Evaluation

**Method**

Exams/Tests

**Integration**

Exams/Tests include a variety of question formats that evaluate student comprehension of lectures, assigned readings, lecture and laboratory exercises. These examinations include knowledge necessary to collect, analyze and present drone collected digital imagery and other forms of digital information and applications related to the course learning outcomes as well as technical processes and procedures and historical and current context information related to collection of digital imagery.

**DE Adaptations for MOE**

Online exams use the applications found in the CMS to access a variety of question formats to assess knowledge of terms, concepts, methods, and applications. Evaluation/grading and constructive comments are supplied to students using the CMS grading system as well as in both informal and formal asynchronous discussion sessions. Students are encouraged to use informal student to student discussions of examination materials within the CMS using accessible protocols.

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**Method**

Class Participation

**Integration**

Students will demonstrate a mastery of course objectives through their ability to discuss drone flight and imagery and digital data collection spatial analysis problems. Students are required to propose flight digital data collection hypotheses, suggest appropriate data collection methods and analytical tools, and evaluate the accuracy of their results. Student participation in these activities are graded with a rubric representing various levels of assimilation of course content.

**DE Adaptations for MOE**

Asynchronous Discussion forums are made available, in accessible formats, using the CMS on scientific method. The instructor monitors the quantity and quality of participation. Evaluation/grading and constructive comments are supplied to students using the CMS grading system as well as in formal asynchronous discussion sessions within the CMS.

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**Method**

Portfolios

**Integration**

Students develop portfolios of drone collected digital imagery and other digital data. Students are required to collect remote sensing images and initiate the development of portfolios represented by data collected using sUAS, drones. The portfolio represents the use of a number of different formats, sUAS platforms, cameras, and analytical and presentation tools.

**DE Adaptations for MOE**

Demonstrations and activities involving real-world scenarios are presented within the CMS. Students prepare and present a final portfolio project using a variety of different digital/teleconferencing media, live chat and/or discussion forums in the CMS, course management system. Presentations are recorded asynchronously or given synchronously when available. In either format students are evaluated by their peers and by the instructor. All projects must meet accessibility standards. Evaluation/grading and constructive comments are supplied to students using the CMS grading system as well as in both informal and formal asynchronous student-student and student-instructor discussion sessions.

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**Method**

Presentations

**Integration**

Students give demonstrations of drone flights and flight plans designed to collect remote sensing data. The presentations include demonstration of a drone flight including pre and post drone flight information and representations of data collected during the flight.

**DE Adaptations for MOE**

Presentations are recorded for asynchronous submission in the CMS course shell and/ or are presented in synchronous meetings designed for these activities using digital meeting technologies such as ZOOM. Presentations are required to be made available in the course management system using accessible formats. Evaluation/grading and constructive comments are supplied to students using the CMS grading system as well as in both informal and formal asynchronous discussion sessions.

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**Method**

Homework

**Integration**

Homework exercises focus on drone and imagery hardware and software techniques, applications, concepts and terms. In particular students will explore, define and evaluate problems associated with acquisition and accuracy of sUAS collected digital data used to formulate and interpret imagery.

**DE Adaptations for MOE**

Weekly exercises focus on drone and imagery hardware, and software techniques and applications and are submitted to the CMS, course management system, or other accessible approved appropriate software for grading. Information and specific instruction on how to complete the homework assignments will be available in the course management system using rubrics developed for individual homework assignments. All homework is provided in accessible formats for applicable. Evaluation/grading and constructive comments are supplied to students using the CMS grading system as well as in both informal and formal asynchronous discussion sessions.

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**Method**

Final Performance

**Integration**

From in-class lectures, demonstrations and laboratory activities involving real-world scenarios, students prepare and present a final drone imagery collection and interpretation project. This project is designed to incorporate each of the course's learning objectives and includes not only written dialog on the use of a remote sensing imagery products; but, discussion of the potential of diverse human responses to various aspects of the project. Students are evaluated on the design, research, selection of drone platform, photographic methods used, artistic and accuracy of data presentation.

**DE Adaptations for MOE**

Practical drone collected digital imagery applications, based on real world scenarios, are developed by students. Students prepare and present a final drone imagery collection and interpretation project using various attributes of the CMS. Student may complete

the assignment individually and/or in facilitated laboratory groups and submit the assignment using the CMS (course management system). Laboratory activity instructions and information will be in the course management system using an accessible format.

## Assignments

**Assignment Type**
Reading

**In-class and/or outside of class**
Outside of class

**Formative or Summative**
Formative

**Assignment**
Gather information to develop a drone flight application (plan) to remotely collect imagery or other digital data for a geospatial product. Read to identify and develop a hypothesis to explore multiple imagery/data to be analyzed; determine which imagery will be used and how; and, review steps for analysis and potential outcomes. Research a method, model or application to enhance the use of the project.

**How assignment will be adapted in online format**
Appropriate internet sources are suggested within the CMS. These sources may include searchable library resources as well as professional journal articles, symposium proceedings, and other on-line resources. Summaries of the readings are submitted asynchronously using the CMS. Evaluation/grading and constructive comments are supplied to students using the CMS grading system as well as in both informal and formal asynchronous discussion sessions. Formal grading is done within the CMS grading application.

**Assignment Type**
Writing

**In-class and/or outside of class**
In-class
Outside of class

**Formative or Summative**
Summative

**Assignment**
Research, evaluate and provide a written summary of a remote sensing, drone collected, photographic, video or other remotely collected data project. Include the type of drone used, camera, geographic data and temporal data relevant to the project.

**How assignment will be adapted in online format**
Writing assignments are presented, using appropriate accessibility standards, within the CMS. Individual and group assignment may be submitted asynchronously in a variety of different formats within the CMS. Informal "laboratory group" discussions are made available within the CMS to promote student/student interaction in the completion and evaluation of assignments. Evaluation/ grading and constructive comments are supplied to students using the CMS grading applications and formal asynchronous discussion sessions. Formal grading is done within the CMS grading application.

**Assignment Type**
Other

**In-class and/or outside of class**
In-class

**Formative or Summative**

Formative

**Assignment**

With one or more lab partners, work as a team to program and operate a drone equipped with a sensor, GPS, video and/or still photography, for digital data collection. Demonstrate the flight program and digital data collection.

**How assignment will be adapted in online format**

Students will develop drone application videos submitted to and made available within the CMS and/or provide links to accessible videos within the CMS. Assignments are submitted, evaluated, and graded within the CMS. Students access instructor evaluations and constructive comments within the CMS grading and discussion applications.

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**Assignment Type**

Reading

**In-class and/or outside of class**

In-class
Outside of class

**Formative or Summative**

Formative

**Assignment**

Using the Internet, library, textbook, or other professional/academic resources, research and evaluate examples of sUAS remotely collected imagery data which describes socio-economic, cultural, gender, and other pertinent imagery data to reflect the diversity of individuals and populations represented in the geospatial environment.

**How assignment will be adapted in online format**

Appropriate internet sources are suggested within the CMS. These sources may include searchable library resources as well as professional journal articles, symposium proceedings, and other on-line resources. Summaries of the readings are submitted asynchronously using the CMS. Evaluation/grading and constructive comments are supplied to students using the CMS grading system as well as in both informal and formal asynchronous discussion sessions. Formal grading is done within the CMS grading application.

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**Assignment Type**

Reading

**In-class and/or outside of class**

Outside of class

**Formative or Summative**

Summative

**Assignment**

Read the article, "Rapidly Processed Drone Imagery Improves California Wildfire Response" https://www.esri.com/about/newsroom/arcnews/rapidly-processed-drone-imagery-improves-california-wildfire-response/?srsltid=AfmBOopQHZulx9asw4CWmSOf5vgKd_4ImlJMOOunmD2h86Im7YmVnPlK.

Summarize the use of drone generated imagery in natural disaster responses such as wildfires.

**How assignment will be adapted in online format**

The appropriate internet source for the article is defined within the CMS. Other sources may also be available including searchable library resources as well as professional journal articles, symposium proceedings, and other on-line resources. Summary of the reading is submitted asynchronously using the CMS. Evaluation/grading and constructive comments are supplied to students using the CMS grading system as well as in both informal and formal asynchronous discussion sessions. Formal grading is done within the CMS grading application.

**Assignment Type**
Reading

**In-class and/or outside of class**
Outside of class

**Formative or Summative**
Summative

**Assignment**
Read the ESRI article, "Rapidly Processed Drone Imagery Improves California Wildfire Response". Summarize how drone imagery is being used in response to natural disasters such as the wildfires we have been experiencing in California.

## Course Materials

**Textbooks**
Remote Sensing with ArcGIS Pro: 2nd Ed., Tammy E. Parece, John A. McGee, 2023, Virginia Geospatial Extension Program, ISBN-13 979-8854833301

**Other Resources**
Aerial Photography and Videography Using Drones, 1st Ed., Eric Cheng, 2015, Peachpit Press, ISBN-10: 0-13-412277-1 ISBN-13: 978-0-13-412277-9

Remote Sensing: Principles, Interpretation, and Applications, Fourth Edition 4th Ed., Floyd F. Sabins Jr., James M. Ellis, 2020, ISBN-13: 978-1478637103, ISBN-10: 1478637102

Introduction to Remote Sensing 6th Ed. B. Campbell, Randolph H. Wynne, Valerie A. Thomas, 2022, The Guilford Press, ISBN-10 1462549403, ISBN-13 978-1462549405

**Open Educational Resources**
Digital Foundations: Introduction to Media Design with the Adobe Creative Cloud - Revised Edition; Michael Mandiberg

Copyright Year: 2017; Publisher: Open Oregon Educational Resources https://open.umn.edu/opentextbooks/textbooks/686

## Class Size Information

**Class Size**
24

**Class Size Category**
J - Specialty lab

## Diversity and Inclusion

**Explain how diversity and inclusion(e.g., gender, culture/race, sexuality, etc.) is infused into the course.**
The course operates with a foundational intention of diversity and inclusion. Included in the objectives, is the necessity of teaching diverse content from multicultural and intersectional perspectives across all aspects of the course content. Emphasis is placed on the articulation of how drone technology data collection and analysis contributes to the discipline of geospatial science. The course offers students' opportunities to foster empathy, expose variant interpretations, and exhibit diverse societal concerns represented by the geographic distribution of humans around the globe. The course content is designed to align objectives with and to create opportunities for students from a variety of backgrounds to hone new skills while acknowledging and honoring their diverse, existing knowledge base. The course emphasizes the need to present remotely collected imagery documenting not only geophysical aspects of human geospatial distribution, but as well, the socio-cultural perspective as it pertains to race, gender identity, sexual orientation, and cultural differences. Students are expected to use GIS imagery which considers cultural, economic, political, and gender-based positioning in developing assignments affecting the geospatial imagery of human activities. Assignments are formatted to allow

students to reflect on their cultural frame of reference and to investigate their personal perspectives as to the geospatial imagery of the communities to which they associate.

**Describe how assignments, instruction, evaluation, course content, and interactions are contextualized for diverse learners promoting an equitable course.**

The course emphasizes the aspects that diverse learners bring to the use of drone technologies to investigate not only the geophysical aspects of the imagery collected using sUAS; but as well, the socio-cultural perspective, as it pertains to their individual ethnic, race, gender identity, sexual orientation, and cultural differences. Students are expected to call on their own experiences to contextualize how imagery data collection and analysis relate to their representation of the diversity of human populations. Students explore how their own diverse learning styles and methods of inquiry contribute to the collection and analysis of drone imagery data. Students are encouraged to consider factors representing their personal cultural, economic, political, and gender-based positioning in developing assignments affecting the imagery representations of the geospatial distribution of human activities. Students are urged to consider not only how photographic and video imagery have affected their own geographic distribution but how they are used in a "historical context" to capture the deeper connections between socio-historical forces and the geospatial distribution of humans.

## Interactions

**Explain how the course will incorporate student-to-student interaction.**

Students are encouraged to work together to solve geospatial imagery problems both in lecture and laboratory situations. Student are required to participate in weekly student to student discussion sessions on topics related to the course materials. Students are organized into laboratory work groups to simulate working conditions in the production of drone collected imagery. Drone flight imagery collection specifically involves student to student interaction between the drone pilot and the camera operator. As an example, one of the assignment requirements is that; with one or more lab partners, students work as a team to program and operate a drone equipped with a sensor, GPS, video and/or still photography, for digital data collection.

**Explain how the course will incorporate instructor-to-student interaction.**

The instructor facilitates instructor to student interactions by encouraging and requiring students to reflect on course topics and articulate an understanding of the material to the instructor and other students. Laboratory instruction is designed to include intensive instructor/student one-on-one instruction in the use of the drone data collection applications and software. To better support a diverse range of learners, instructors are encouraged to work individually with students to incorporate formative and summative active learning strategies in the both the lecture and laboratory assignments which promote students to ask questions and get clarification of examples from the instructor.

**Explain how the course will incorporate student-to-content interaction.**

Student to content interaction is incorporated in both lecture and laboratory presentations and assignments as well as the semester "Capstone" project. Students are required to apply lecture content to application laboratory assignments. Students are introduced to content in the lecture portion of the class and interact with the content in many ways including researching relevant information, summarizing lecture presentations, taking short quizzes, participating in discussions, project development and semester examinations. Laboratory assignments require students to produce drone acquired digital output using information discussed and developed in lecture. This output represents a variety of data presentations all of which include mapping and data analysis of specific geospatially related questions; what resources are being explored; who (the diversity of populations) are impacted by the resources; where the resources are congregated and the historical data influencing the geospatial distributions.

**Explain how the course will incorporate student-to-self interaction (metacognitive).**

The goal is to support students in connecting their personal experiences with drone collected imagery and data with the terminology and concepts involved in image collection and presentation presented in the course. Students are encouraged to validate their own life experience by seeing themselves in the use of the material and assignment requirements. Class activities, reading, lecture, discussions and student drone collected imagery projects encourage and allow students to explore various personal interpretations and understandings of their individual relationships to the use of drone collected geospatial imagery related to their own diversity, socio-economic status, gender, ethic-racial background and other aspects of their own identity and history.

Key: 2977