The University Senate of Michigan Technological University
Proposal 69-21
(Voting Units: Academic)

Establishment of a New Graduate Certificate in Advanced Photogrammetry and Mapping with UAS

Submitted by: Department of Civil & Environmental Engineering

1. **Proposal Date:**
   February 1, 2021

2. **Proposing Contacts and Department:**
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   Department of Civil & Environmental Engineering

3. **Sponsor Department Approvals**
   At the end of the document

4. **General Description and Characteristics of Program:**

4.1 General Description of Certificate

This Civil & Environmental Engineering Department at Michigan Technological University proposes a nine-credit Certificate in Advanced Photogrammetry and Mapping with unmanned aerial systems (UAS). The graduate certificate in Advanced Photogrammetry and Mapping with UAS has the following three objectives.

i) Attract students who want to be prepared for the mapping use of UAS and Satellite Imagery and be prepared for the professional certifications as ASPRS Mapping Scientists or UAS Scientists(https://www.asprs.org/certification);
ii) To provide students applied geospatial science and technology skills, including sensors and their calibration methods, digital photogrammetry and photogrammetric computer vision, UAS flight planning, Earth Observation Systems (EOS) imagery photogrammetric processing, accuracy and digital representation of 2D products and 3D models;

iii) To provide students fundamental applied skills in photogrammetric modeling and simulation, including calibration, adjustments, and assessment of geospatial data obtaining system performance for use in various application scenarios.

4.2 Catalog Description

The Certificate in Advanced Photogrammetry and Mapping with UAS is designed to develop skills and competencies in photogrammetric modeling and simulation, including calibration, adjustments, and assessment of geospatial data obtaining system performance for use in various application scenarios. The curriculum builds skills for geospatial data processing technologies design, and exploration, while working with geospatial data from real-world application scenarios.

5. Rationale for Certificate:

The Advanced Photogrammetry and Mapping with UAS Certificate will serve three potential student populations. First, the certificate will provide students in geospatial engineering and integrated geospatial technology at Michigan Tech with a path to gaining skills and knowledge in EOS and photogrammetric engineering. This pathway would be available to current students on-campus or students enrolled online.

Second, current Michigan Tech graduate students from a wide range of disciplines such as civil, environmental, geological, computer engineering, data science and forestry who are seeking to equip themselves for a geospatial data and technologies driven world. The proposed Graduate Certificate will provide academic and hands-on training in photogrammetry, mapping based on UAV and satellite imagery to students from various backgrounds civil engineering, forestry, geosciences, computational sciences, and computer engineering. This nine-credit certificate will provide a strong foundation in photogrammetric engineering that most students can fit into their curriculum.

Third, working geospatial professionals in the private sector, aerospace industry and multiple government agencies may require skills and knowledge they did not gain during their undergraduate education but are required for projects and research opportunities that are presented in their current career. Photogrammetric engineering and operational knowledge of UAS and EOS are essential for many industries. Companies who attended the Fall 2020 Michigan Tech career fair indicated they there require employees to have skills associated with exploration of geospatial data acquired from UAS and EOS. Specifically, Surveying Engineering industry constantly is looking for CED credits for the licensed professionals towards NSPS CED programs [https://www.nsps.us.com/page/EducationPolicy#]. Therefore, another intended audience for the certificate consists of geospatial workforce representatives working on their education advancement.

6. Related Programs:

There are several related online photogrammetric engineering and UAS/EOS mapping programs. Examples include:

- University of Florida , Fort Lauderdale, Florida, Face-to-face only. University of Florida offers 9-credit **"**Mapping with Unmanned Aerial Systems" Graduate Certificate that focuses on the emerging area of mapping using small unmanned aerial systems (sUAS). This certificate will enhance the geomatics education of graduate students and working professionals, addressing the needs of industry for individuals competent in the acquisition of high-resolution geospatial information. Topics will include foundational knowledge, vehicle and mapping systems operation, and geospatial applications. https://flrec.ifas.ufl.edu/geomatics/programs/graduate/mapping-with-unmanned-aerial-systems-graduate-certificate/index.html /

- University of Denver, Online, Denver Colorado. Graduate Certificate "GIS and Unmanned Aircraft Systems", is devoted to the use of unmanned aircraft systems (UAS), or drones, for mapping and analysis. Certificate consist of 16 credits – 4 courses of 4 credits each https://universitycollege.du.edu/gis/degree/certificate/gis-and-unmanned-aircraft-systems-online/degreeid/596

- Penn State University, Online, College Station Pennsylvania – Graduate certificate in Remote Sensing and Earth Observation (12 credits). The Penn State World Campus Graduate Certificate in Remote Sensing and Earth Observation provides a foundation in remote sensing, terrain mapping, and image analysis for the geospatial professional who possesses a working knowledge of fundamental principles in GIS. https://www.worldcampus.psu.edu/degrees-and-certificates/penn-state-online-remote-sensing-earth-observation-certificate/overview

- University of New Hampshire, face-to face, Durham New Hampshire **–** Drone (UAV/UAS) Operator Certificate program is a multi-workshop program that is offered in partnership with the NH Department of Transportation. https://training.unh.edu/droneoperator

- Florida Atlantic University, face-to-face, undergraduate certificate in Geomatics Engineering. This certificate has prerequisite of 7 elementary surveying credits and assumes another 6 electives credits of coursework that include photogrammetry. http://www.cege.fau.edu/undergraduate/geomatics_certificate.php

7. Projected Enrollments:

Initially, the majority of enrollment will consist of current Michigan Tech students. integrated Geospatial Technology master's program students will earn that certificate automatically while taking certificate courses as elective in pursuit of their master's degree. Based on the current growing geospatial courses enrollments, we expect the program to grow over the next several academic years. If enrollment exceeds projections, in particular through online enrollment, additional resources will be required (see section 15 below).

Semester	On-campus Enrollment	On-line Enrollment
Fall 2021	2 students	3 students
Fall 2022	2-5 students	2-5 students
Fall 2023	5-10 students	5-10 students
Fall 2024	5-10 students	10-15 students
Fall 2025	10-15 students	15-20 students

8. Scheduling Plans:

No change in the regular scheduling of the existing courses is anticipated.

9. Curriculum Design:

Coursework: 9 credits, two required courses (6 credits) and choose 1 elective course (3 credits) for certificate completion (only 3 credits may be at the 4000 level):

Required courses:
SU4140 Photogrammetry and Mapping with UAS (3 cr., Fall)
SU5540 Advanced Photogrammetry – Satellite Photogrammetry (3cr., Fall/Spring)

Elective Courses (one of the following):
SU5541 Close-Range Photogrammetry (3cr., Fall/Spring)
SU5010 Geospatial Concepts Technologies and Data (3 cr., Spring)
SU5142 3D Surveying and Modeling with Laser Scanner Data (3 cr., Fall/Spring)
SU5013 Hydrographic Mapping and Surveying (3 cr., Spring)

10. Course Descriptions

SU4140 Photogrammetry and Mapping with UAS* (3 cr., Fall)
Basic principles of photogrammetry and its role as a technology for spatial data collection. Use of photogrammetry in the fields of surveying, engineering, and geographic information management will be discussed. Special attention to UAV photogrammetry.

SU5540 Advanced Photogrammetry – Satellite Photogrammetry (3cr. Fall/Spring)
Fundamentals of spaceborne imaging systems relevant to topographic mapping. Imagery products: preprocessing levels and metadata. Specific methods of space photogrammetry. Review of contemporary spaceborne imaging systems and imagery products available. Airborne non-frame sensors and photogrammetric processing of the imagery.

SU5541 Close-Range Photogrammetry (3cr., Fall/Spring)
The main topics that will be covered are: math fundamentals; imaging technology; the photogrammetric process; image acquisition planning; interior orientation; bundle block adjustment; 3D plotting; orthoprojection; image-matching techniques; and close range photogrammetry applications.

SU5010 Geospatial Concepts Technologies and Data (3 cr., Spring)
High-level review of geospatial data acquisition systems, sensors and associated processing technologies. Course considers geospatial metadata generation principles, interoperability, and major tools for manipulation with geospatial data. Course may help in transition of non-geospatial majors to geospatial fields.

SU5142 3D Surveying and Modeling with Laser Scanner Data (3 cr., Fall/Spring)
Theory and application of LIDAR scanning. Typical application scenarios are also included. Intensive lab component provides hands-on experience in LIDAR point cloud processing and visualization.

SU5013 Hydrographic Mapping and Surveying (3 cr., Spring)
This course comprises theory and applications of hydrographic mapping technologies. Typical application scenarios are covered. An intensive lab component provides hands-on experience in hydrographic data processing and visualization.

Notes:
*Only up to 3 credits at the 4000 level can be used toward the certificate.

All SU courses listed above are already developed and are delivered in asynchronous online mode.

11. Model Schedule Demonstrating Completion Time

The Certificate can be completed in a 1 or 2 semester sequence or spread over 3 semesters (depending on student preference and scheduling requirements). The courses are offered in the semester listed below. Students can start any semester for increased flexibility. Once courses are all online, faculty may teach the courses other semesters as overload. A 2-semester example schedule is shown below.

<u>Fall Semester</u>

SU4140, Photogrammetry and Mapping with UAS

Spring Semester
SU5540 Advanced Photogrammetry – Satellite Photogrammetry
SU5541 Close-Range Photogrammetry

12. Library and other Learning Resources

No library or other learning resources are required at this time.

13. Faculty Resumes

The following faculty will be supporting the program.

Eugene Levin Ph.D, CP , Associate Professor
https://www.mtu.edu/epssi/members/levin/

Jeffery Hollingsworth, PS,GISP, Professor of Practice
https://www.mtu.edu/cee/people/faculty-staff/faculty/hollingsworth/

Filiberto Chiabrando, Ph.D, Adjunct Professor
https://www.dad.polito.it/personale/scheda/(nominativo)/filiberto.chiabrando

14. Equipment

No additional equipment will be required.

15. Program Costs

Initially, the certificate will not incur additional costs, as we anticipate that the initial enrollment load can be covered with our current faculty. As online instruction enrollment grows, the additional costs associated with instruction will be covered from tuition return from the students who are enrolled online.

16. Space

There are no new space requirements.

17. Policies, Regulations, and Rules

Not applicable

18. Accreditation Requirements

Michigan Tech is accredited by the Higher Learning Commission (HLC). The proposed certificate will meet HLC criteria 3 and 4. The proposed certificate will not seek additional accreditation.

19. Planned Implementation Date

Fall 2021

20. Assessment

Students earning this certificate will be able to

GLO1. Solve photogrammetric engineering problems, and apply their solution to real world application scenarios.

GLO2. Process photogrammetrically UAS and satellite imagery to extract positionally accurate geospatial information.

21. Approval Process

Departmental Graduate Committee: February 1, 2021
Department: February 16, 2021
College of Engineering: , 2021
Provost's Office and Deans' Council: , 2021
Graduate School: , 2021
Approved by the Senate:
Approved by the President: