PROGRAMA DE PÓS-GRADUAÇÃO EM AGRONOMIA		
COURSE: **AGRICULTURAL USE OF DRONES** **2019**	**2 days course** **Credit hours: 16 h**	**Theorectical: 08 h** **Practical: 08 h**
Responsible professor: Dr. Murilo Maeda – TEXAS A&M University **Dr. Fábio Rafael Echer - UNOESTE**		

I – OBJECTIVES

Provide the students with theoretical and practical knowledge on agricultural use of drones, their use on research and crop monitoring.

II – COURSE DESCRIPTION

The use of Unmanned Aerial Systems in agricultural research will be discussed in this course. Topics will include platforms, sensors, data collection, data validation, data processing, and interpretation. The course will also include a visit and in-field demonstration with a local UAV/UAS technology company.

III - SYLLABUS

Topics to be discussed include:

1. Background on UAV remote sensing technology in agriculture and current needs

2. Sensors and platforms available, as well as their current limitations and trade-offs (area coverage vs. image resolution)

3. Current "systems approach" adopted at Texas A&M University (AgriLife Research - Extension)

4. Field data collection workflow and importance of standard operating protocols

5. Brief overview of data processing workflow, challenges, and bottlenecks

6. Crop monitoring using UAS, possibilities, needs, and reality

7. Live demonstration of an online web-portal for UAS data and research collaboration (UAShub.tamucc.edu)

8. Current industry approach, possibilities, needs, and challenges/limitations (with local industry/company partner)

9. Local in-field demonstration of UAS data collection and data processing routines (with local industry/company partner)

IV – TEACHING METHODOLOGY

Audio-visual resources will be used for the theoretical classes. At least one practical class will be provided in an experimental field/site with local industry/company partner.

V – ASSESSMENT OF ACQUIRED KNOWLEDGE

Assessment will be performed by a written exam at the end of the course.

VI – REFERENCE LIST

6.1 Relevant Scientific Papers

- Chang, A., Jung, J., Maeda, M., & Landivar, J. (2017). Crop height monitoring with digital imagery from Unmanned Aerial System (UAS). Science Direct, 141,232-237 doi:10.1016/j.compag.2017.07.008
- Chen, R., Chu, T., Landivar, J., Yang, C., & Maeda, M. (2017). Monitoring cotton (Gossypium hirsutum L.) germination using ultrahigh-resolution UAS images. Precision Agriculture, 19(1)161-177 doi:10.1007/s11119-017-9508-7
- Chu, T., Chen, R., Landivar, J., Maeda, M., Yang, C., & Starek, M. (2016). Cotton growth modeling and assessment using unmanned aircraft system visual-band imagery. J. Appl. Remote Sens, 10(3), 036018. doi: 10.11 17/1.JRS.10.036018
- Enciso, J., Jung, J., Anjin, A., Chavez, J. C., Yeom, J., Landivar, J., Cavazos, G., **(2018)** Assessing land leveling needs and performance with unmanned aerial system, *Journal of Applied Remote Sensing.* 12(1), 016001, doi: 10.1117/1.JRS.12.01600.
- Enciso, J., Maeda, M., Landivar, J., Jung, J., Chang, A., (2017). A ground based platform for high throughput phenotyping, *Computers and Electronics in Agriculture* 141(2017): 286-291.
- Farber, C. and Kurouski, D. **(2018)** Detection and Identification of Plant Pathogens on Maize Kernels with a Handheld Raman Spectrometer, *Analytical Chemistry.*, 90, 3009-3012.

- Kunz J.N., Voronine D.V., Ko B.A., Lee H.W.H., Rana A., Bagavathiannan M. V., Sokolov A. V., Scully M. O., (2016) **Interaction of femtosecond laser pulses with plants: towards distinguishing weeds and crops using plasma temperature.** *Journal of Machine Optics (in press)*.
- Malambo, L., Popescu, S., Murray, S., Putman, E., Pugh, A., Horne, D., Richardson, G., Sheridan, R., Rooney, W. L., Avant, R., Vidrine, M., McCutchen, B., Baltensperger, D., & Bishop, M. (2017). Multitemporal field-based plant height estimation using 3D point clouds generated from small unmanned aerial systems high-resolution imagery. *International Journal of Applied Earth Observation and Geoinformation. (64) 31-42.*
- Murray, S.C. (2017). **Optical Sensors Advancing Precision in Agricultural Production.** Photonics.com
- Murray, S.C., Knox, L., Hartley, B., Méndez-Dorado, M.A., Richardson, G., Thomasson, A., Shi, Y., Rajan, N., Neely, H., Bagavathiannan, M., Dong, X., & Rooney, W. (2016). **High clearance phenotyping systems for season-long measurement of corn, sorghum and other row crops to complement unmanned aerial vehicle systems.** SPIE 9866-4
- Neely, H. L., Morgan, C., L. S., Stanislav, S., Rouze, G., Shi, Y., Thomasson, A., Valasek, J., & Olsenholler, J. (2016). **Strategies for soil-based precision agriculture in cotton.** Defense and Commercial Sensing Conf. Bellingham, WA: SPIE.
- Pugh, A. N., Horne, D. W., Murray, S. C., Carvalho, G., Malambo, L., Jung, J., Chang, A., Maeda, M., Popescu, S., Chue, T., Stareke, M. T., Brewer, J. M., Richardson, G., & Rooney, W. L. (2017). **Temporal Estimates of Crop Growth in Sorghum and Maize Breeding Enabled by Unmanned Aerial Systems,** *The Plant Phenome Journal*, doi: 10.2135/tppji2017.08.0006
- Rouze, G.S., Neely, H.L., Morgan, C.L.S., Yang, C. **(2018)**. Spatial analysis of multispectral and thermal imagery from multiple platforms. Defense and Commercial Sensing Conf. Orlando, FL: SPIE.
- Shafian, S., Rajan, N., Schnell, R., Bagavanthiannan, M., Valasek, J., Shi, Y., & Olsenholler, J. **(2018)**. Unmanned aerial systems-based remote sensing for monitoring sorghum and development. *PLOS ONE,* doi.org/10.1371/journal.pone.0196605
- Shi, Y., Thomasson, A., Murray, S., Pugh, A., Rooney, W., Shafian, S., Rajan, N., Rouze, G., Morgan, C., Neely, H., Rana, A., Bagavathiannan, M., Henrickson, J., Bowden, E., Valasek, J., Olsenholler, J., Bishop, M., Sheridan, R., Putman, E., Popescu, S., Burks, T., Cope, D., Ibrahim, A., McCutchen, B., Baltensperger, D., Avant, R., Vidrine, M., & Yang, C. (2016) **Unmanned Aerial Vehicles for High-Throughput Phenotyping and Agronomic Research.** *PLOS ONE*, 11.7
- Shi, Y., Murray, S., Rooney, W., Valasek, J., Olsenholler, J., Pugh, A., Henrickson, J., Bowden, E., Zhang, D., & Thomasson, A. (2016). **Corn and sorghum phenotyping using a fixed-wing UAV-based remote sensing system.** SPIE 9866-11
- Song, H., Yang, C., Zhang, J., He, D., & Thomasson, A. (2015). **Combining fuzzy set theory and nonlinear stretching enhancement for unsupervised classification of cotton root rot.** *J. Appl. Remote Sens.* 9 (1), 096013 (August 26, 2015); doi: 10.1117/1.JRS.9.096013. *[indirectly related]*
- Stanton, C., Starek, M., Elliot, N., Brewer, M., Maeda, M., & Chu, T. (2017). Unmanned aircraft system-derived crop height and normalized difference vegetation index metrics for sorghum yield and aphid stress assessment. J. Appl. Remote Sens, 11(2), 026035. doi:10.11 17/1.JRS.11.026035

- Thomasson, A., Shi, Y., Olsenholler, J., Valasek, J., Murray, S., & Bishop, M. (2016). **Comprehensive UAV agricultural remote-sensing research at Texas A&M University**. SPIE 9866-28
- Valasek, J., & Thomasson, A. (2016). **Autonomous Air and Ground Sensing Systems for Agricultural Optimization and Phenotyping.** Defense and Commercial Sensing Conf. Bellingham, WA: SPIE.
- Yeom, J., Jung, J., Chang, A., Maeda, M., & Landivar, J. (2017). Cotton growth modeling using unmanned aerial vehicle vegetation indices.International Geoscience and Remote Sensing Symposium, Fort Worth, TX.
- Yang, C., Odvody, G., Thomasson, A., Isakeit, T., Minzenmayer, R., Drake, D., & Nichols, R. **(2018)**. Site-specific management of cotton root rot using airborne and high resolution satellite imagery and variable rate technology. Trans. ASABE
- Yang, C., Odvody, G., Thomasson, A., Isakeit, T., & Nichols, R. (2016). **Change detection of cotton root rot infection over 10-year intervals using airborne multispectral imagery.** *Comput. Electron. Agric.* 123(1):154-162. *[indirectly related]*
- Zhang, D., Zhou, X., Zhang, J., Yubin Lan, Y., Xu, C., Liang, D., **(2018)** Detection of rice sheath blight using an unmanned aerial system with high-resolution color and multispectral imaging, PLOS ONE, 13.5

6.3 Relevant Scientific Journals

Computers and Electronics in Agriculture

Precision Agriculture

Journal of Applied Remote Sensing

Analytical Chemistry

Journal of Machine Optics

International Journal of Applied Earth Observation and Geoinformation

SPIE

The Plant Phenome Journal

PLOS ONE

6.4 Relevant websites in agriculture

www.scielo.br

www.embrapa.br

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