PROCEEDINGS

GRSS YOUNG PROFESSIONALS AND ISPRS SC SUMMER SCHOOL

Federal University of Mato Grosso do Sul
Campo Grande/MS Brazil
October 28 to November 1, 2018

Hermerson Pistori; José Marcato Junior; Amaury Antônio de Castro Júnior; Edson Takashi Matsubara; Maurício de Souza Celso Soares Costa; Isadora Taborda Silva e Nayara Vasconcelos Estrabis.

Hemerson Pistori; José Marcato Junior; Amaury Antônio de Castro Júnior; Edson Takashi Matsubara; Mauricio de Souza; Celso Soares Costa; Isadora Taborda Silva e Nayara Vasconcelos Estrabis

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About IEEE/GRSS-Young Professionals & ISPRS WG V/5 and Student Consortium SS

This is the fourth edition of the event so called "IEEE/GRSS-Young Professionals & ISPRS WG V/5 and Student Consortium SS", this year (2018) it will be hosted at UFMS, campus of Campo Grande / MS, with the theme: UAV Photogrammetry and Machine Learning Applications: Emerging Trends and Challenges for Earth Observation.

Mato Grosso do Sul is a state that covers four biomes: Cerrado, Pantanal, Mata Atlântica and Chaco. The State also stands out in activities related to agribusiness, which due to the population increase and its demand for food, require not only precision and efficiency in productivity management but also protection of the environment.

Remote Sensing and Photogrammetry make it possible to map and to monitor resources through orbital images or through images collected with UAV. They also support precision agriculture, what leads to a greater productive efficiency, and reduce the need on use of pesticides. In this sense, it becomes of great importance to acknowledge what exists in the most recent researches (state of the art) both in the technological aspect and in the methods/techniques of Photogrammetry, Remote Sensing and Machine Learning. The event has the support of ISPRS (International Society for Photogrammetry and Remote Sensing) and IEEE GRSS (Geoscience & Remote Sensing Society), and will contribute to strengthen the graduate school in Mato Grosso do Sul.

The event will be organized in two blocks. The first, lasting one day, follows the model of GRSS Young Professionals. It is intended to guide the careers of young professionals who have bee graduated up to 15 years and consists of lectures and interactive sessions delivered and moderated by prominent professionals active in business, education/research institutions and academia.

The second block, lasting three days, will follow the model of the ISPRS Summer School, aiming to transmit technical/scientific knowledge on the selected topic. In this block, presentations will be performed by three renowned speakers with great technical and scientific experience in the field: Dr. Farid Melgani (University of Trento), Dr. Franz Rottensteiner (Leibniz University Hannover) and Dra. Anette Eltner (TU Dresden).

Themes of Interest

- UAV and orbital imagery orientation
- Sensor systems: design, calibration and evaluation
- Hyperspectral Remote Sensing
- Microwave Remote Sensing
- DSM and DTM generation
- Time series analysis of remote sensing data
- Remote sensing applied to environmental studies
- Images and Video Coding
- Image/video analysis
- Image/video filtering and restoration
- Image/video registration
- Image/video segmentation
- Motion Detection and Tracking
- Shape representation and matching
- Surface Reconstruction and Representation
- Projective Geometry and Computer Vision
- Texture and Color in Computer Vision
- Feature extraction
- Feature Matching, Inference and Recognition
- Deep Learning
- Pattern Recognition in Computer Vision
- Architectural models for Computer Vision
- Design methods for systems of Vision
- Real-time Computer Vision
- Visual Inspection and Robotics

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ASSESSMENT OF AIRBORNE LASER SCANNING DATA CLASSIFICATION FROM LASTOOLS SOFTWARE

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The 3D point clouds acquired with LiDAR systems have been used in the extraction of different objects: buildings, trees, roads, power lines, planar surfaces, ground and vehicles; which are fundamental for digital terrain modelling, surface representation and acquisition/update of geographic information systems. The classification is an important task in this context, and can be synthetized as being the process of assigning one class to each point. This process can be performed by different approaches and many attributes can be considered. Nearest Neighbor, Support Vector Machine and Random Forest are examples of classifiers often used. With respect to attributes, the following features are explored: intensity, height above DTM, variance of point elevations, variance of principal curvature, entropy of point elevations, eigenvalue-based features, approximate plane parameters (sum, mean and standard deviation of residuals), direction and variance of normal vector. Besides, there is the possibility of using different software, for instance, *CloudCompare* (https://www.danielgm.net/cc/), *LAStools* (https://rapidlasso.com/), *OPALS* (http://geo.tuwien.ac.at/opals/html/index.html), *Quick Terrain Modeler* (from Applied Imagery), *Terrasolid* (https://www.terrasolid.com/home.php). In this work the *LAStools* software suite was explored, specifically the *lasclassify* tool which classifies the non-ground points into two classes: vegetation and building. The separation of the classes is performed by means of set of thresholds, that can be defined by the user: building planarity (t_{planar}), forest ruggedness (t_{rugged}) and ground offset (t_{offset}). The experiments were performed using a LiDAR dataset of the city of Vaihingen/Germany, which can be obtained from the ISPRS (International Society of Photogrammetry and Remote Sensing) webpage. The point cloud available, with point density between 4 and 7 pts/m^2, was generated by one Airborne LASER Scanning (ALS) system Leica ALS50. The dataset considered has around 800,000 points and an average point density of 6.7 pts/m^2. The experiments were performed considering the default thresholds (t_{planar} = 0.1 m; t_{rugged} = 0.4 m; and t_{offset} = 2 m) and the quality analysis was performed using as reference the information available in the same dataset, which was manually labeled. To perform the quantitative analysis the following quality parameters were estimated: completeness (Comp), correctness (Corr) and F_{score}. From the results, it can be seen that around 12.5% of points were labeled as unclassified, since they did not attend neither building nor vegetation class. The vegetation class presented F_{score} around 84%, whereas for building class the F_{score} was 93%. Also, for the building class the $Comp_{Building}$ was around 92% and the $Corr_{Building}$ was around 95%. The obtained quality parameters are compatible with the values presented in ISPRS webpage, considering different classification methods for this dataset, indicating the potentiality of the *LAStools* and *lasclassify* tool in the LiDAR classification, especially to identify buildings.

HYPERSPECTRAL DATA CUBE TO MAPPING MINERAL DIVERSITY ON CARBONATIC BASIN

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Although the Earth Observing One (EO-1) satellite was launched as an experimental platform through NASA's New Millenium Program, it has completed more than seventeen years of activity, imaging the Earth through its two unique instruments, the Advanced Land Imager (ALI) and Hyperion. Hyperion in particular was the only hyperspectral instrument to have been launched aboard an orbital platform until then and was able to provide the only available global samples of the Earth's surface with a spectral coverage over almost the entire optical spectrum in contiguous bands of 10 nm (VNIRSWIR, 0.4-2.5 µm). The treatment of hyperspectral data for whatever may be their applications in the mapping segment generates a "Big Data" problem. The main idea of this project is based on an experimental evaluation of the use of scenes from the Hyperion instrument, correlating them to already characterized and detailed field data, and exploring the efficiency of the Google Earth Engine (GEE) cloud platform to solve "Big Data"problems and boost the speed of data processing within the digital image processing chain. GEE enables access to remote sensing products via EarthExplorer/USGS directly to the cloud platform. The study is carried out in two distinct areas, both in the domain of Neoproterozoic related carbonatic sequences. The domain of the study area covers the Irecê Basin and the Una-Utinga Basin, which have variant lithostratigraphy among several carbonatic facies. The data for each scene consists of 242 bands, of which 196 calibrated/useful bands are available for hyperspectral applications. Our approach in this project integrates a customization plan of algorithms available in commercial software and includes the execution of the entire traditional chain of pre-processing hyperspectral data, as well as other techniques, such as the implementation of vegetation indices for the delimitation of areas susceptible to extraction of endmembers and the application of several band reasons, in order to facilitate the delimitation of geological domains. Until then it was possible to conclude that there is coherence between the results generated by mineral indices with three main groups of previously mapped carbonatic rocks: impure dolomitic limestones (clay rich), calcitic calcilutites, dolomites and dolarenites. The indices can also provide a differentiation of the main outcrops of dolomite and calcitic carbonates. The satisfactory correlation between these results and the field data should demonstrate the importance of the efficiency of a digital image processing cloud platform, such as GEE. In addition, it should highlight the usefulness of the presence of hyperspectral remote sensing in works of mineral exploration programs, as a component of the system that leads to the design of predictive metalogenetic models, both in the initial stages, being a regional scale, as well as in the advanced stages, of prospectus or deposit scales.

OPTIMIZED BUILDING ROOF MODELLING WITH STRATIFIED RANDOM SAMPLE CONSENSUS

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Model-driven approaches for automatic extraction of building roof planes from point clouds usually attempts to adjust a predefined mathematical model (planes) to the data. Some examples are the 3D Hough Transform and the random sample consensus (RANSAC) algorithm. Although independent from the dataset size, the original formulation used to compute the number of iterations for the RANSAC algorithm requires three quantities: the minimum number of parameters necessary to fit the selected mathematical model (three for planes) and two probabilities that are unknown prior to the computations. The first probability is related to the assurance that at least one of the sampled observations sets includes only inliers, and this value is directly proportional to the number of iterations. The second consists in the probability that a given data item is an inlier, and can be computed a posteriori from the results as the proportion of inliers over the dataset size, or estimated a priori based on knowledge about the data. This second probability is inversely proportional to the number of iterations, having an exponential impact into the result. Alternatively, it is possible to generate reasonable approximations for the second probability and therefore estimate dynamically the number of iterations from available data. In this study a data-driven approach to produce a candidate consensus-set for building roof-plane detection using a stratified random sample consensus (sRANSAC) algorithm was applied to a point cloud acquired by airborne LASER scanning systems. The main idea is to perform an initial classification to generate consensus-set approximations, therefore optimizing the sampling mechanism compared to the original RANSAC. The adopted method to perform the initial classification consist in using mathematical morphology operators to filter ground returns, and local variance information descriptors to detect potential planar regions. Since the sRANSAC is flexible in this regard, other approaches can be considered for the classification, depending on the available data, such as intensity of the pulse return and radiometric data from aerial images, for instance. The only requirement is that the selected method for the initial classification must provide an approximated detection of the points belonging to building roofs, that is, aboveground flat surfaces. These points are then clustered with a region growing algorithm, therefore producing the approximate domains for the sRANSAC. Thus, the algorithm can prioritize the sampling process considering only points pre-classified as belonging to planar segments, and the number of iterations can be estimated dynamically from available data. The experiments were conducted using a point cloud from the Unesp Photogrammetric Data Set captured with a RIEGL LMS-Q680i at a 500 m flying height, resulting in an average density of 12.5 pts/m^2. The results obtained from the aforementioned data indicate that the sRANSAC was able to reduce the number of iterations for building roof-plane detection by at least 2.43 times compared to RANSAC, as well as providing an accuracy improvement of around 4.1%.

REMOTE SENSING APPLIED TO THE WATER STORAGE ESTIMATION IN THE PARANA BASIN

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During the biennium 2013/14 a scenario of water crisis became real in São Paulo, which is located in the Paraná basin. The watersheds are management units, being in the basin where all types of activities occur (such as industrial, human, agricultural, among others). In this way a hydrological study of the basin allows the decision making in relation to water resources to be more effective. In this context, the main aim of this work was to conduct a multitemporal analysis of water storage in the Paraná basin between 2002 and 2014. Water storage data provided by the GRACE (Gravity Recovery and Climate Experiment) mission was used with spatial resolution of 1°x1°. For a more detailed analysis, the Paraná basin was divided into six sub-basins, being "Grande", "Paraná Verde", "Paranaíba", Paraná Paranapanema"," Paraná Tietê" and "Paraná Iguaçu ". Correlation of water storage data with precipitation TRMM (Tropical Rainfall Measuring Mission), available for free of charge by Giovanni (NASA), and evapotranspiration MOD16 (Moderate Resolution Imaging Spectroradiometer), available for free of charge by NTSG (University of Montana), orbital data was also performed, aiming at identifying the periods of greater drought occurrence, as well as quantifying the reduction along the basin. The data (TRMM, MOD16 and GRACE) were processed in the same way. The trimming was done using the shapefile of each sub basin. Afterwards, the statistics of each clipping were extracted and the data obtained were tabulated to facilitate comprehension. It was possible to verify that the water crisis of 2013/14 was the most severe pronounced in recent years. It was also possible to verify that the GRACE data are more suitable for larger basins, which are present in a large part of the territory, without disregarding the shape of the basin (being the “Paraná-Iguaçu” sub-basin as an example of how shape and size influence the results). It was also possible to verify that the data correlation (GRACE / TRMM and GRACE / MOD16) is higher than 75%, with only the "Paraná-Iguaçu" sub-basin with a correlation below 60% in both comparisons.

AN SPATIAL-TEMPORAL IMAGE SEGMENTATION APPROACH THROUGH PRINCIPAL COMPONENTS IMAGERY

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Land-use and land-cover (LULC) information are essential to evaluate and support natural resources management and sustainable practices, therefore it is important to improve the quality of these products. Satellite Image Time Series (SITS) analysis arises as a possibility to improve the quality of LULC maps since the land cover phenology takes place in this data source, so the multi-temporal characteristics can be used to decrease the misclassification in targets that have a similar spectral signature in an image of one single date. Despite the SITS analysis advantages, this approach can be time consuming due to spatial and temporal resolutions and can lead to misclassified pixels even in homogeneous areas due to a pixel-based approach. The object-based approach is a possible solution for the mentioned issues, where one SITS is built for every spatial-temporal homogeneous area. Therefore, it is necessary to define spatial-temporal homogeneous areas by a segmentation process. In a regular segmentation process, an image is decomposed in spatial homogeneous regions (superpixels). However, in object-based STIS analysis, superpixels are required to be spatial and temporal homogeneous, which means that each superpixel should separate regions where there is the same land cover type or change along the time. Regardless of the importance of the temporal segmentation, there is yet a lack of approaches designed for this purpose. Some studies have used as approach defining the segments over an image of one single date and carry out the analysis considering that the regions are stable along the time; however, such approach can lead to misclassification issues. As an alternative approach, we performed the segmentation process over the first three principal components (PCs) imagery, built from Enhanced Vegetation Index (EVI) SITS. Landsat images with 30 meters spatial resolution were used to build the EVI SITS. Two test sites within the Landsat scene (path 233 and row 066) were defined to evaluate the approach. For the first and second test site were used images acquired in 7 and 9 different dates respectively. The first three PCs imagery were chosen due to these images present most of the uncorrelated information that exists in the original SITS, and due to the uncorrelated information be the land cover changes that happened along the time. The algorithm used to perform the segmentation was the Simple Linear Iterative Clustering Zero (SLICO), and the number of segments parameter was changed iteratively producing different results. Precision and Recall metrics were used to compare the segmentation results of our proposed approach with the segmentation carried out over an image of one single date. Both metrics for both test sites point out that the segmentation over the PCs imagery produces better spatial-temporal segments than the segmentation over one single date image. The precision and recall values increased as the number of segments in the SLICO algorithm was increased, reaching values above 0.85 for both metrics when the number of segments was set higher than 3500. Despite the good performance pointed out for our proposed approach, the number of segments to set in the SLICO algorithm is an issue, since it depends on the size of the test site as well as the size of the land cover changes that take place in the study site. Therefore, further analysis with other segmentation algorithms is required.

OFF-THE-SHELF CAMERA STABILITY ASSESSMENT

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The technological advances have contributed to improve the resolution and quality of off-the-shelf cameras and to the development of new platforms, for instance, the Remotely Piloted Aircraft Systems (RPAS). Both, cameras and platforms have been applied in many photogrammetric activities, such as: MDS generation, MDT extraction, building extraction, surface modelling, 3D point cloud generation, etc. Considering that the quality of the photogrammetric data output is directly related to the geometric accuracy of the camera imaging sensor, and off-the-shelf cameras were not developed for metric purposes, it is important to ensure the precision of Inner Orientation Parameters (IOPs). In this context, several researches have been carried out with the purpose of investigating the stability and accuracy of the IOPs. Thus, this study aimed to evaluate the IOPs significance and stability of one camera (Canon ELPH 110 HS RGB) embedded in an RPAS (SenseFly eBee). The evaluation considered the analysis of significance of the parameters used in the calibration model through statistical analysis and also the stability of IOPs set through bundle similarity analysis. For that, the calibration process was performed considering several epochs in order to analyze temporal variation of the parameters, since the equipment can be influenced by temperature variation, vibrations and impacts during the landing. The images were acquired in one tree-dimensional calibration field located in FCT-UNESP, adopting strategies to minimize the correlation between the parameters, for example acquire convergent images. Among the parameters considered in the calibration model are focal length, principal point position, symmetric radial distortion, decentering distortion and affinity distortion. The IOPs significance were tested through statistical methods based on Fisher-Snedecor distribution and the magnitude of the correction provided by each parameter. Those parameters that are considered statistically not significant and that provides correction values smaller than half of a pixel were disregarded from the IOPs set. To compare two IOPs sets derived from two temporally-spaced calibration sessions, three quantitative methods were used to analyze the camera stability: ZROT (Zero Rotation method), ROT (Rotation method) and SPR (Single Photo Rotation method). These methods are based on submit a set of images point (c, l) to different IOPs sets to proceed the inner orientation process. The results from the inner orientation processes is compared and the stability of camera is admitted if the RMSE results were less than 0.5 pixel. Despite the IOP significance statistical analysis pointed to the elimination of parameter K_3 from IOPs set, it was not eliminated due to magnitude of the correction provided by this parameter, around 8 pixels at sensor's border. The IOP sets that presented best results for stability analyses reached RMSE values of 0.53 pixel regarding to ZROT and ROT methods. The SPR methods indicates the acceptance of stability in some cases, however the SPR method allows the absorption of IOPs errors by external orientation parameters. Thus, the similarity bundle analysis pointed to differences between the reconstructed bundles from different epochs. From the results, it is possible to conclude that the analyzed camera should not be considered as a stable equipment. Therefore, since it is not possible to guarantee that the parameters resulting from a calibration process will be maintained over time, it is recommended to perform on-the-job (or on-site) camera calibration.

ESTIMATION OF THE BIOMASS OF GROUND COVER PLANTS USING UNMANNED AERIAL VEHICLE (UAV)

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The present work aims to investigate the application of UAV in the estimation of plant biomass for soil cover. Soil cover plants are essential in the process of nutrient loss of agricultural land, avoiding erosion and contributing to the accumulation of nitrogen in plants. The objectives are to determine the height and fresh and dry biomass of the soil cover plants and to correlate them with the data collected with UAV. In addition, the proposal is based on encouraging references on this topic to the State of Mato Grosso do Sul in Brazil. The fieldwork stage was carried out in a rural area in the municipality of Campo Grande-MS, Brazil. For the experimental design, five species of green manure (*guandu, feijão de porco, crotalária juncea, calopogônio e estilozante campo grande*) were used, arranged in a randomized complete block design with 4 replicates. The green manures were sown in lines spaced 0.5 m and density recommended by Calegari et al. (2014). The plots had a total area of 3 × 7, where each was divided into a measuring area of 3 × 4 m - for UAV evaluation, and a sampling area of 3 × 3 m - for on-site sample collection. The evaluations of plant height and height estimated by UAV and fresh and dry biomass of the plants were performed every 21 days until the green manures were in the final stage of flowering and beginning of grain formation. To determine the fresh and dry biomass the cover plants were cut to the ground, packed in paper bags, weighed in the fresh mass and then forced to the forced ventilation oven at 65 ° C + 2 ° C until for the determination of the dry mass. In the UAV procedure, an overflight was carried out in the area immediately after sowing, to elaborate the digital elevation model (MDE) of the area. The other flyovers were performed every 21 days. The UAV model used was the Dji Phantom 4 Advanced and the Ebee RTK model with Parrot Sequoia multispectral camera with RGB, Red Edge and Infra Red (IR) bands. To enable centimeter accuracy in the elaboration of the MDE, control points (raised with GNSS receivers - Global Navigation Satellite System / RTK - Real Time Kinematic) were used in the field. To produce the Digital Terrain Model (MDE) we used the software Pix4D and QGIS 2.18.13. Currently, the present study is ongoing. Data collection in the field work and with UAV, has already been completed. In total, six flyovers were made in the area. Now the studies continue with the analysis of the correlation between height and biomass of the plant collected in loco and the height and biomass estimated with the UAV and estimated biomass in the laboratory. And regression analyzes, to adjust equations for each crop that relate the UAV data to the biomass. The advantage of such analyzes is to result in the possibility of estimating the biomass using only the UAV in large areas with these crops.

MULTISOURCE DATA FOR LAND USE/COVER CLASSIFICATION USING MACHINE LEARNING

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The damming of rivers with hydroelectric potential has an important role in socio-economic development, as well as promoting resources for multiple uses of water. However, the sensitivity of these water bodies to the forms of land use/cover in their surroundings is currently one of the factors that most impact continental waters. As a consequence, these environments are increasingly eutrophic favoring the excessive proliferation of aquatic vegetation. Remote sensing can provide capabilities to perform an effective monitoring of aquatic vegetation. However, one of the main limitations with regard to the classification of remote sensing data is the discrimination of targets that have similar spectral signatures, for instance, the aquatic and terrestrial vegetations. Machine learning algorithms have been presented as a promising alternative with potential for remote sensing images classification. They differ in their ability to manipulate large dimensionalities data and mapping of classes with complex characteristics. Therefore, our research work aims to integrate data from different sources (multispectral images and Digital Elevation Model (DEM)) in a process of information extraction based on artificial neural network (ANN) supervised classification by pixel and, through this approach perform the simultaneous mapping of aquatic macrophytes and the land use/cover in the surrounding of Salto Grande reservoir, Americana - SP. In addition, assess the capability of these data to discriminate areas occupied by macrophytes from terrestrial vegetation. The Weka 3.8 data mining software was used to classify the images. Three experiments were carried out. As a classifier, the Multilayer Perceptron ANNs were used and the learning algorithm was the backpropagation. This step sought to investigate the influence of input planes on the discrimination of output classes. In addition, different architectures were trained by varying the numbers of neurons in the first and second hidden layers. For all the experiments, the learning rate (α) of 0.01 and moment rate with as 0.1 was defined. The sigmodal activation function was used. Also, it established the number of training times as being 3000. The training file was split into two sets of pixels, 80% of the sampled pixels were used for training and 20% for validation. As input data for the ANN, was considered four Landsat-8 OLI (Operational Land Imager) multispectral bands (green, red, near infrared and medium infrared regions) acquired in 2015, 2016 and 2017, three spectral indices (NDVI, NDWI and NDBI), two IHS images colour composition (OLI2, OLI3 and OLI4) and (OLI4, OLI5 and OLI6), the ASTER DEM and the texture images. The texture images were generated from the calculation of the fragmentation index, implemented in Idrisi software. The fragmentation index was computed on the spectral band OLI 3, OLI4, OLI5 and OLI6. The extracted textural feature was the index of fragmentation implemented in Idrisi software. The textural index was calculated in a window of size 3x3 using four multispectral bands (OLI3, OLI4, OLI5, and OLI6). The metrics used in accuracy assessment were kappa, overall accuracy, and the RMSE. The results show that all the experiments presented kappa index higher than 0.95. The second experiment was the one that presented a lower kappa index, probably due to the exclusion of the DEM from the training data. From the results was possible to notice that the input data assist to minimize the ambiguity between spectrally similar classes and also that the DEM has the potential to aid in the discrimination between macrophytes and other vegetation types, mainly the macrophyte classes and cropland areas. Additionally, was founded that the NDWI index and the intensity component (I) of the IHS transformation did not present significant contributions in the classification of land use/cover categories.

SPATIO-TEMPORAL ANALYSIS OF SOIL EROSION USING REMOTE SENSING TO EVALUATE PES

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Soil is the most important asset to food production and economic development. Inadequate soil management has been intensifying erosion process, mainly in food producers countries as Brazil. Thereby, Payments for Environmental Services (PES) is a popular incentive-based instrument for encouraging landowners to contribute to soil and water conservation. Although the principle sounds simple and straight-forward, understanding PES cost-effectiveness is challenging. Here, we assessed whether PES programme met its objectives of reducing soil erosion in a rural basin, mainly used for livestock production. We used remote sensing to quantitatively obtained land cover changes over the study period converting into an erosion parameter, so that we could analyze the efficiency of PES. To comprehend the soil conservation practices behavior over time, we considered results obtained from the Universal Soil Loss Equation (USLE). The cover and management factor (C) was obtained from Normalized Difference Vegetation Index (NDVI) by using Landsat 8 satellite images from dry and wet seasons from 2013 to 2016. We also obtained the P-factor analyzing Campo Grande City Hall reports of the PES program that considered terracing practices. As result, we found soil loss estimate of each year and, therefore, soil loss decrease due to soil conservation. We identified that 9% of the basin area was comprised of conservation and restoration of forest and riparian vegetation. Besides, soil conservation practice, which consisted of terracing, covered 29% of the basin area. Altogether, these conservation practices are expressive when we consider the multiple land use of the study basin. Our results show that soil conservation practices reduced soil loss estimate over the period from 2.4 to 1.8 ton ha-1.yr-1. Although recent PSE implementation, those findings demonstrate significant decrease in soil erosion, implying the PES program to be effective. Those conservation practices are important to maintaining the ecosystem biota plus reducing agricultural costs.

PAVEMENT CONDITION EVALUATION USING UAV IMAGES

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Transportation infrastructure needs constant maintenance. Pavement management systems requires reliable and detailed data of the current state of the roads to make effective decisions. Currently, pavement condition evaluation methods are mostly performed manually with visual inspection and interpretations *in situ*, which is labor intensive, time consuming and expensive. Further, the numerous distinct types of defects that a road can have and varying degrees of damage, this usually results in subjective or inaccurate reports. In order to monitor vast and extensive network of roads, the rising availability and affordability of remote sensing techniques offers new potential for pavement assessment. These methodologies are faster, semi-autonomously and can evaluate larger areas. The problem is to obtain automatically information from the data collected from the remote sensing technologies and report accurately the condition of the road faster and cheaper than traditional methods. This paper explores different available methods of determining pavement distress through remote sensing using UAV (Unmanned Aerial Vehicle) photography. An experiment was conducted on a road in severe damage conditions. Images were obtained with a consumer camera on rotary wing UAV and GCPs (Ground Control Points) were distributed along the road. This work compares free and commercial techniques of assessing the data collected using traditional and state-of-the-art computer vision algorithms. It also compares to other current techniques that do not rely on remote sensing and concerns about possible negative issues using UAVs. Additionally, the difficulties on how to address norms and technical standards in automated pavement condition evaluation are considered. Finally, it is presented in which cases is it viable or not to implement such autonomous systems and substitute current methodology taking in account parameters such as: precision, reliability, costs, scalability and ease of operation.

PREDICTION OF LIVE WEIGHT OF CATTLE USING UAVs: PRELIMINARY RESULTS

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The estimation of the live weight of beef cattle is an important source of information for the evaluation of growth rate and food efficiency, contributes to genetic selection, diet assessment and extraction of information on the environmental conditions imposed on them. In addition, the importance of knowing the weight of the animals arranged in the same batch is reflected in management actions such as batch composition, pasture rotation and supplementation. The use of Unmanned Aerial Vehicle (UAVs) allows the acquisition of images of cattle arranged in batches, without the need of moving the animals or separating them. For that, an approach was proposed to estimate the live weight of cattle in feedlot batches, through images of the same ones, acquired by UAVs using computer vision and regression techniques. For this, aerial images captured with a DJI Phantom 4 were used, the height of 80 meters in a flight that resulted in a set of 11 images of an experimental confinement installed in School farm of UFMS/FAMEZ. The animals were arranged in individual paddocks with a structure equipped with feeders and water through, totalizing 22 Nellore animals. The captured images were segmented using the Simple Linear Iterative Clustering algorithm (SLIC), configured to segment the image into 5000 segments, Gaussian kernel diameter at 7.0 and compactness, which balances the proximity of color and space by 20. These parameters were chosen for better segmentation of cattle. Visually, 15 superpixel corresponding to the

dorsum images of the cattle. For each superpixel the live weight corresponding to the animal in the segmented was attributed, from which some features were extracted using the descriptors of Histogram of Oriented Gradients (HOG), Hu's Moment Invariants, Gabor Filter (GFs), Local Binary Patterns (LBP) and Gray Level Co-occurrence Matrix (GLCM). The features extracted from the superpixels were submitted as input to the Linear Regression and SVM algorithms implemented for regression with the WEKA 3.8.2 standard parameters. We performed the experiment with the data extracted with the split percentage of 66% for training and the remaining for testing. The SVM algorithm obtained the best results, with its correlation coefficient of 0.9123, mean absolute error of 24.06 kilograms, while Linear Regression presented the correlation coefficient of 0.7954 , mean absolute error of 28.68 kilograms. Despite the high correlation, we can say that this model can not be generalized since the amount of data does not allow an adequate sample in relation to the amount of predictor variables tested. However, we believe that the presented results, although preliminary, are encouraging to support research that seeks to explore the use of computer vision to estimate the weight of cattle through aerial images.

EFFECTS OF IMAGES OVERLAP IN THE GENERATION OF ORTHOMOSAIC IN FOREST CONTEXT

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In order to respond to new scientific and ecological questions, and thus to be able to monitor the most diverse forest changes, an accurate characterization of theses ecosystems is necessary and, there are tools available in the market, such as: Remotely Piloted Aircraft Systems (RPAS); Global Navigation Satellite System (GNSS); robust data processing software's and hardware's. The main aim was to investigate the effects of image overlap in the generation of orthomosaic in forest area. A RPAS flight with Phantom 4 was carried out on the UFMS (Federal University of Mato Grosso do Sul) campus, getting 423 images in an area of 3.26ha. Experiments considering different overlap values for the same flight were performed in Pix4D software. The overlap has been manipulated by removing certain images. It was verified that reducing the image overlap did not implied in an increase of Ground Control Points RMSE (Root Mean Square Error). The generated orthomosaic were stored and will be used to generate a forest cartographic database, which can be used in the future by researchers anywhere in the world, in this way, enriching this and other works, creating a database where it will be possible to compare results of different research, using the same imagery dataset. It is initially proposed to use these images and classification methods to: (1) Monitor changes in the composition of tree species in forests, such changes may be due to several factors such as: global warming; irregular deforestation; among others. (2) Serve as a source of information to assist the creation of large or small-scale forest inventories. The data generated from these forests RPAS's imaging, also have the objective of being the basis for creating new methods and concepts on forest and ecological research.

ANALYSIS OF THE SPATIAL DYNAMICS OF LAND COVER IN A PANTANAL REGION

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The Pantanal is the world's largest wetland area and presents great heterogeneity, where geomorphometric conditions form subregions with different characteristics. Miranda-Abobral is one of these, where seasonal floods favor natural environment conditions while make it difficult to maintain economic activities in the major part of the area. However, livestock and agriculture are practiced in the Southeast region due to favorable topography. The objective of this research is to perform multitemporal analysis of land cover in Miranda-Abobral by using reclassified NDVI, considering annual rainfall patterns. The Normalized Difference Vegetation Index (NDVI) remotely describes the vegetation state of conservation of an area and its biomass. It is expressed by the spectral reflectance difference between near-infrared (NIR) and red (Red) regions divided by the sum of these wavelengths. Vegetated areas result in positive values in NDVI, exposed soils present values around zero, while water results in negative values. NDVI was calculated for Surface Reflectance (SR) data of Landsat 5 satellite for the years of 2000, 2006 and 2011, while Landsat 8 SR data were used to calculate NDVI for the year of 2016. The images covered the drought period of the years. NDVI was then reclassified by delimiting the extreme values of the following spectral coverage classes: Dense Vegetation (DV); Sparse Vegetation (SV), Undergrowth (UG) and No Vegetation (NV). The rainfall data were obtained by the third level class TRMM satellite data, which presents monthly rainfall rate in mm/h, combining information from the three main rainfall sensors (PR, TMI and VIRS). In August 2000 SV class represented 49% of the study area, RV 38%, DV 12% and NV 1%. However, at the same period of 2006, the UG covered 50% of the study area to the detriment of SV (36%), but NV remained with 1% and DV increased to 13%, due to a four-month drought prior to imaging. In August 2011, SV expanded to 43% and UG reduced to 40%, DV represented 15% and NV 2% of the surface under study. In 2016, the dry season presented a higher rainfall incidence than the other years in Miranda-Abobral, hence vigorous vegetation responded with higher average NDVI values. SV covered 54% of the subregion, RV covered 30%, RV remained with approximately 15% soil cover and ND returned to 1%. Dry season was well defined in the years of 2000, 2006 and 2011, with durations of 3 to 5 months. On the other hand, rainfalls during the drought season in the year of 2016 overcame the other studied years. Therefore, it can be noticed that the dynamics of the landscape in Miranda-Abobral is directly influenced by the pluviometric conditions of the Upper Paraguay River Basin. Furthermore, this research corroborates with the viability of the Landsat Surface Reflectance products and the TRMM precipitation data in monitoring landscape dynamics.

THE IMPACT OF IMAGE OVERLAP ON STRUCTURE-FROM-MOTION PHOTOGRAMMETRY

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Planialtimetric surveys compose the basis of engineering services, so ensuring the accuracy of measurements at this stage is vital to ensure compliance with design dimensions and the correct positioning of elements in works of any proportions. Due to the popularization of RPAS (Remotely Piloted Aircraft Systems) and aerial photogrammetry services performed by them, there was a great increase in the offer of services in the area, but there are still many doubts in the technical-scientific environment regarding the consequences of the flight parameters used. Overlapping degrees, number of control points (GCPs) and checkpoints are some of the most important parameters when generating cartographic products through photogrammetry because the accuracy of these products depends directly on them. The objective of this study was to characterize the impact of image overlays, through comparisons of accuracy, on products generated from planialtimetric surveys performed with RPAS. Two types of sensors (multispectral and RGB) were used and the image processing had a variation of overlapping rates between 30% and 90%. Experiments were performed in Pix4D software. As a result, minimum values for overlapping rates were suggested according to the desired scale of the cartographic product and the accuracy established by the Cartographic Accuracy Standard.

MACHINE LEARNING APPLIED TO *TABEBUIA SP*. CLASSIFICATION USING UAV IMAGERY

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Brazil is a country with the highest number of taxons, distributed in six types of biomes, and its flora is considered one of the most important in the world due to its climate heterogeneity, being one of the factors that contribute to this floristic diversity. There are three types of Biomes in the State of Mato Grosso do Sul: Cerrado, Pantanal and Atlantic Forest. Cerrado is a throughout of them, with several forest species being the *Tabebuia* (including species recently migrated to the genus *Handroanthus*), also known as Ipê, one of the most attractive due to its beauty and flowers color. Belonging to the genus Tabebuia and family Bignoniaceae, this species occurs naturally along all over the State. *Tabebuia spp*. wood has a great economic value, being considered noble. Due to this economic importance and the advancement of agriculture and cattle breeding in the state, the condition of forests and native fields comes over the years, through human action, changing and consequently modifying the natural landscape. The aim of the paper was to investigate machine learning techniques for the classification of *Tabebuia spp*. from images collected by UAV. Images were captured using DJI Phantom 4 UAV in the UFMS area, with a flight height of 50 meters in June, 2018, resulting in images containing the species *Tabebuia*. Pynovisão software was used, in which the segmentation with SLIC (Simple Linear Iterative Clustering) was performed, considering 250 segments and 10 for compactness. Images were segmented and visually annotated with the respective *Tabebuia sp* and other classes. The superpixels were used to the construction of the image dataset, with 116 superpixels for Tabebuia and 125 superpixels for others, being this any other vegetation different from *Tabebuia sp*. We considered the following extractors: Color Statistics, Gray Level Co-occurrence Matrix (GLCM), Histogram of Oriented Gradient (HOG), and Local Binary Patterns (LBP). For the classification purposes, the SMO (Sequential Minimal Optimization) was used to train support vector machines. The accuracy analysis was performed with images not used in the training procedure, and a value of 93% was obtained, indicating the potential of machine learning techniques for the classification of tree species from UAV high spatial resolution imagery.

VOLUMETRIC SURVEY WITH DRONES IN OPEN PIT MINES

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The control of the extracted material volume in open pit mines have vital economic and environmental importance for their operation. In order to guarantee the maximum possible use of the bedrock, without extrapolating the permitted extraction limit, periodic volumetric surveys are necessary. The reliability of such measurements depends directly on the methodology and equipment used. In general cases, geometric simplifications of volume are performed, and then measurements are made by measuring tape, total station, or other GPS equipment. Although this is the usual methodology, it produces a low number of points for virtual modeling of its real shape, consecutively reducing its accuracy, which no longer happens when using photogrammetry measurement, where a cloud of points is produced through the images. The objective of this study is to evaluate if the volumetric survey from RPAS, by image processing (structure from motion photogrammetry) produces an accurate result and close to the real need presented in quarries. Comparisons were made between two software (Pix4D and Agisoft Photoscan) and with a field truth. From the results obtained it was possible to conclude that such an application is not only possible but it guarantees an accurate and efficient measurement of the areas and volumes of material storage in quarries.

MULTITEMPORAL ANALYSIS OF CONTINENTAL WETLANDS: THE CASE STUDY OF THE NABILEQUE PANTANAL

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The Pantanal, a sedimentary basin of Quaternary origin, is the largest floodplain in the world and due to its ecological importance it is considered a World Heritage Site. The flood pulses of the Pantanal rivers make their ecological control and their subregions have differences between them, being marked by own characteristics of rainfall, flood regime and structural control. The subregion of the Nabileque is formed by a river megafan and has its own characteristics, such as the late flood and the peculiarity of functioning as a water reserve which accumulates the flow of the Paraguay River and returns it slowly to the main riverbed, which can last up to six months. In this way, the control of this area becomes of extreme environmental importance. The objective of this work is to analyze the dynamics of these wetlands in the Nabileque Pantanal, in the state of Mato Grosso do Sul, where the main economic activities are agriculture and livestock, activities that cause the modification of the original vegetation and alter the quality water resources. In view of this, multitemporal analyzes and geotechnologies are very useful tools for environmental monitoring and control, since they are constantly evolving. For the analysis of water resources, the MNDWI (Modified Normalized Difference Water Index) is superior to the better known NDWI, because in its equation the near infrared band is changed by the medium infrared band, which increases the contrast of the flooded areas and not flooded, also excluding interferences, such as built-up areas. The images used were Sentinel 2, since they have bands with spatial resolution of 10, 20 and 60 meters, obtained during flood and dry seasons and available free of charge. The processing was done through the free software QGIS. The use of free data and software allows academic community accessibility to methods and results, facilitating the reapplication of techniques in future studies. For the analysis of the MNDWI results, a color palette was applied in a continuous way, without establishing classes, to visualize the real areas of water, wet area and vegetation. The contrast generated by the colors made it possible to perceive the changes that occurred during the months, from the dry season to the flood season and its spatialisation. In partial results, the tests performed have shown that the MNDWI index generated satisfactory responses in the flooded areas of the Nabileque Pantanal, evidencing the dynamics of water.

PROJECTED LAND-USE AND CLIMATE CHANGE IMPACTS ON SOIL EROSION IN THE AMAZON

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The Amazon biome contains the largest rainforest in the world, with great cultural and environmental diversity. The Amazon forests are vital to the Earth's carbon cycle. For decades it has undergone the pressure created by the challenge of conciliating development policies and conservation goals, leading to expressive land-use changes. However, Brazil rigorous public policies has shown its capability of reversing a historical trend of deforestation in the Brazilian Amazon. Land-use change is closely related to climate, and they are both important factors for soil loss dynamics. Amazon has been massively studied under different land-use and climate change scenarios. However, there are few studies concerning soil loss in the Amazon, much less integrates projected scenarios to erosion in a biome scale. Therefore, this research studies the predicted soil loss changes in the Brazilian part of Amazon Biome, under projected changes in land-use and climate, in different scenarios, in different future periods. Climate changes were projected by two different general circulation models: Hadley Center Global Environment Model version 2 (HadGEM2-ES) and Model for Interdisciplinary Research On Climate version 5 (MIROC5), in medium and high emission scenarios. Land-use changes were projected under low carbon and reference logics. Thus, 64 combination of projected climate and soil-use scenarios were used to estimate Brazilian Amazon average soil loss under different emission scenarios. Average soil loss was calculated by the Revised Universal Soil Loss Equation (RUSLE). The mean of all the combinations results in an average soil loss rate of 9.539 t · ha−1 · yr−1. MIROC5 RCP8.5 climate scenario combined with reference land-use scenario for 2050 demonstrates to be the riskiest scenario. The lowest value, considered to be the “best” possible situation occur in 2015 when combinating HadGEM2-ES with low carbon scenario, resulting in 9.3635 t · ha−1 · yr−1. Amazon soil loss pattern takes riskier when considering the emergent deforestation hotspots in Peruvian and Bolivian Amazon.

VIS-NIRS AS AN ENVIRONMENTALLY-FRIENDLY METHOD TO PREDICT LAMB MEAT QUALITY

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The increase of sheep meat supply in Brazil is associated with the improvement of the production systems, in order to meet the great demand of the consumer market. For this to occur, several ways of analyzing the meat quality have been used, either by the chemical composition as the quantification of the amount of fat (Ethereal Extract, EE) or by the softness, evaluated by the shear force of the samples. The physical-chemical analysis techniques of the meats require time, financial and water resources, in addition to using toxic chemicals, generating residues that can cause impacts to the environment if not well managed. Near infrared spectroscopy (Vis-NIRS) has been tested as an alternative to traditional laboratory analysis, since it is a non-destructive, simple, fast and safe method to evaluate meat quality, without the generation of residues and harmful impacts to the environment . The present study aimed to develop equations for the prediction of ovine meat quality through the Vis-NIRS technique. Fifteen male Texel breed lambs carcasses of six month old, were used. After slaughter the carcasses were cooled for 24 hours at 2 ° C and samples of Longissimus thoracis muscle (LT) were collected for analysis of pH, color (L * a * b *) (L * indicates the brightness, a * and b * are the chromaticity coordinates, which represent two ranges of color being respectively green to red and blue to yellow), shear force (HR) and ethereal extract (EE). The Vis-NIRS spectra were collected in the LT muscle, after the cutting the carcass. The spectrophotometer used a wavelength range of 400 to 1395 nm. The data were submitted to main component analysis and partial least squares regression using The Unscrambler X v.10.3 software. For some characteristics such as pH, L * and EE, Vis-NIRS was not a good predictor, obtaining R^2 of 0.20 (0.1), 0.46 (1.42) and 0.33 (0.73), respectively. Vis-NIRS predictive capacity for a *, b * and shear force was R^2 of 0.6 (1.18), 0.61 (0.98) and 0.78 (0.45), respectively. Vis-NIRS may be an alternative to the physical-chemical analysis of color components and shear force of the meat, however the calibration curves for prediction of brightness and amount of fat should be better adjusted. In this way, the Vis-NIRS is suggested as a technique to predict some quality characteristics of sheep meat, with potential to reduce the use of water resources and possible environmental impacts when compared to the traditional meat quality assessment methods.

USE OF GEOTECHNOLOGIES IN URBAN CLIMATE ANALYSIS

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The urban environment goes through constant changes in the microclimate according to the interaction between environmental influences and relief modified by human action, which is the habitat for most of the world's population. Within this context, the thermal comfort is to elucidate the importance of maintaining correspondence between the inhabited environment and the local climate, aiming at quality of life, especially in aspects related to society, environment and sustainable regional development. Thus, the general objective of this research was to analyze the spatial distribution patterns of climatic variables and evaluate the influence of green areas in the thermal comfort in the city of Campo Grande, in Mato Grosso do Sul. The methodology consists of: multidisciplinary literature review, identification of the spatial distribution of thermal surface patterns in urban areas and urban heat island and freshness through geoprocessing use comparing such LANDSAT-8 (225/74) data to the ambient temperatures also acquired through the application of mobile transects in the summer and winter of 2015 main roads of the city, followed by interpolation of such data in software Idrisi SELVA. Later, NDVI vegetation index was used to correlate weather data with the green areas of the city limits and the dense and impermeable areas. Finally, a synthesis map of the city 's thermal field was elaborated from interpolation of multivariate linear regression model data in which the explanatory variables were: the intra - urban classes identified by the research as dense urbanization, vegetation and dense vegetation; and the distance from the urban center. The dependent variable (to be explained) was the air temperature. A coefficient of determination of 85.41% was obtained as a result, showing that the model fitted the sample. This research aimed to assist in obtaining more accurate information on the influence of climatic elements to the urban context.

LONG-TERM TREND ANALYSIS IN WATER FLUXES ACROSS THE BRAZILIAN CERRADO

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The Cerrado plays a fundamental role in the Brazilian water resources dynamics, distributing fresh water to the largest basins in Brazil and South America, including the Sao Francisco, Tocantins, Parana, and Paraguai. This region provides water supply for industry, agriculture, navigation and tourism, and to hydroelectric energy production. Although some studies evaluating hydrological fluxes have been developed in the Cerrado, few investigations have evaluated trends of hydrological extremes in this region using a long-term time series. Here we evaluated long-term trend in the components of the water balance across the Brazilian Cerrado. Furthermore, we investigated the water balance in three important watersheds of this region, being: Paraná, Tocantins, and São Francisco. We used remote sensing based products of evapotranspiration (ET) and terrestrial water storage (TWS) that came from Global Land surface Evaporation Amsterdam Model (GLEAM) and the Gravity Recovery and Climate Experiment (GRACE), respectively. Observed data of precipitation (P) and discharge (Q) came from of the National Water Agency (ANA). We performed trend analysis at each pixel using the Mann-Kendall test with Sen's slope estimates, considering a 0.05 significance level (95% confidence level) for the time series of P and ET of 1980 to 2015 and for the TWS of 2003 to 2015. We also developed a correlation analysis between the residue of the computed water balance (dS/dt = P – ET – Q) and TWS for the São Francisco, Paraná, and Tocantins river basins. Our results indicate that there have been (a) TWS decreases of up to $-15\ mm\ yr^{-1}$ in the eastern region of the Cerrado, mainly in the São Francisco basin, and an increase of up to $10\ mm\ yr^{-1}$ in the region near the Pantanal biome. We found a P and ET decrease in the Center-West region near the Amazon biome. We noted a significant correlation between the computed dS/dt and TWS ($r > 0.79$) for all studied watersheds. The use of water fluxes data based on remote sensing and observed data provides a useful way to evaluate long-term trends in major water balance components over the Brazilian Cerrado and identify hydrological extremes for large watersheds.

REMOTE SENSING APPLIED TO THE ENVIRONMENTAL REGULARIZATION OF RURAL PROPERTIES

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This study contributed to the recurrent researches that are emerging about land use classification with the purpose of environmental regularization of rural areas in Brazil. The proposal of land use classification methodologies, mainly in the identification of native vegetation, is fundamental for the elaboration of maps validation that allows to identify areas of environmental liabilities. However, free data satellites present some difficulties in obtaining cloudless images, especially in tropical areas, given the existing temporal resolution. Therefore, this research investigated the use of nano-satellite constellation Planet orthoimages, aiming at the land use and coverage mapping and the assessment of the positional accuracy of these images, since this validation was not identified in the literature. Each PlanetScope satellite is a CubeSat 3U (10cm x 10cm x 30cm). The constellation includes approximately 175 satellites with capacity to cover the entire terrestrial surface and daily collection of 300 million km², in addition to the high spatial resolution of 3m. For the positional validation of the Planet images, UTM (E and N) coordinates of 110 Planet Image checkpoints were extracted, and later, homologous points were extracted from the aerial orthoimages of the urban area of Campo Grande / MS (GSD of 10 cm). The RMSE (Root Mean Square Error) was 3.36m (E) and 3.21m (N), that is around 1 GSD. The mean of the discrepancies was 1.03m (E) and -0.78m (N). The planimetric resultant was 4.65 m, that is, less than 2 GSD. Thus, in this research, the positional accuracy was less than 7m in planimetry in 90% of the points, according to the Planet specifications (discrepancies in 80% less than 7 m). The study area for the land use classification was in the Federal University of Mato Grosso do Sul school farm, located in the municipality of Terenos/MS. The defined classes were: native vegetation area, facilities, agrosilvipastoral area, and water accumulation area. The classification was performed in the Google Earth Engine software and presented an overall accuracy value of 99.91% using the Random Forest algorithm. The research's contributions are reinforced by applying them to environmental regulation and combating deforestation, contributing to the natural resources preservation.

A NEW METHODOLOGY FOR CROP FAILURE DETECTION IN UAV IMAGERY BY USING IMAGE PROCESSING BASED ON MATHEMATICAL MORPHOLOGY

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Nowadays, the precision agriculture has brought a variety of tools for optimizing results and preserving the environment, some of them based on the Geomatics Science, as for example, the Geodesy (mainly the use of GNSS - Global Navigation Satellites Systems), Photogrammetry and Remote Sensing, and others. Considering the use of images in several mapping applications, the progress of technology provides a wide range of low-cost sensors, that can be really useful for precision agriculture, such as the cameras that work on visible and infrared spectral range. Currently, high-resolution aerial images acquired by UAVs (Unmanned Aerial Vehicles) have been largely used and studied worldwide to support farm managers to take strategic decisions (rural monitoring), as can be seen at specific literature and news regarding geotechnologies. This management considers different phases of a plantation, from the soil preparation to the harvest, and today all the steps can be assisted by aerial images. Most of the studies about precision agriculture, as can be found in the state-of-the-art, look for solutions regarding crop diseases, water stress, and soil nutrients imbalance using multi and hyperspectral images. However, a common problem found in farm management is the identification and treatment of crop failures, which can cause a substantial loss in the overall plantation scenario. Bearing in mind the problem caused by the crop failures, this work aims to present a new methodology for an automatic crop failure detection, by using image processing. The proposed method considers the mathematical morphology to identify objects (row plantations and corridors) on RGB aerial images (visible spectrum), by applying morphological operators (dilation, erosion, opening, and closing) together with the Hough Line Transform technique. The basic idea is to identify the plantations' rows, map them as straight lines and identify over the lines the presence of failures. Several experiments were carried out using aerial images acquired from a low-cost UAV over coffee plantations in Brazil (with different characteristics). The results show the potential of the methodology for identifying the crop failures using only an RGB sensor – without considering the infrared spectral band and others. The assessment of the failures detection presented a completeness around 97% for the tested areas. This quality index was obtained by comparing the results with a manual identification carried out by a GIS (Geographic Information System) specialist. Based on the results, it is possible to confirm that the use of morphological operators can support the identification of failures in plantations, and consequently, the methodology can assist the management of farms and increase the productivity. Future work is being planned and the main idea is to use machine learning for the crop failures identification and also considering curve patterns over the plantation.

USING COMPUTER VISION, MACHINE LEARNING AND REMOTE SENSING TO IDENTIFY BUILT AREAS AND VEGETATION COVER

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Remote sensing is an important tool that can be used from environmental preservation to territorial delimitation, through a wide range of utilities that include, among other things, analysis of the vegetation covering, environmental inventory, and topographic features. Thus, this tool can also be used for more specific purposes such as identification of different types of vegetation, identification of pollen allergens sources or even for monitoring the growth of built areas over protected areas. In this work, our aim is to present an approach to identify built areas and vegetation cover areas in satellite images using computer vision and machine learning techniques. We used captured images by Landsat 8 (Landsat Data Continuity Mission) and RapidEye satellite images, respectively with 30m and 5m of spatial resolution as well as aerial images with 0,5m spatial resolution. We segment captured images using the Simple Linear Iterative Clustering (SLIC) algorithm. The SLIC clusters pixels into perceptually meaningful atomic regions with similar colors. The pixels clustered by the SLIC form superpixels creating segments in the image. We visually classify each superpixel into two classes: built areas and vegetation cover. After we extracted features from each superpixel using Histogram of Oriented Gradients (HOG), Hu's Moment Invariants, Gabor Filter (GFs), Local Binary Patterns (LBP), Gray Level Co-occurrence Matrix (GLCM) and color information from RGB, HSV and CIELAB color space. The features extracted from the superpixels were input to the K-Nearest Neighborhood (KNN) with k = 4, Support Vector Machines (SVM), Decision Trees (C4.5) and AdaBoost machine learning algorithms with the WEKA 3.8.2 standard parameters. We performed two experiments to analyze the accuracy of machine learning algorithms with images captured from different areas. This allows for comparing the accuracy of the algorithms using different images. In the first and second experiment, we used 270 and 600 superpixels respectively, distributed in a balanced manner among the classes of built areas and vegetation cover. For the training and testing in each experiment, we used 10-folds cross-validation. In the first experiment, with the image captured by Landsat 8, the better accuracies were obtained with the algorithms C4.5 and AdaBoost, both achieved 92.50%. The accuracy using C4.5 to RapidEye images was 91.83%. In the second experiment, the AdaBoost algorithm obtained the best result, the accuracy of 100% with images captured by RapidEye and 88% for Landsat 8 images. In both experiments, the aerial images obtained accuracy of 100%. The worst accuracies reached to Landsat 8 images was using the KNN (k = 4) with 70.83% for the first experiment and accuracy of 77.33% using C4.5 in the second experiment. Although this work is at an early stage, we believe that the results reported are encouraging and can support specialists in remote sensing. Furthermore, we believe that our work can stimulate new approaches to explore the use of computer vision and machine learning for remote sensing of large areas.

H/ALPHA DUAL-POL DECOMPOSITION FOR MAPPING LULC IN A REGION OF AMAZON FOREST

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Human occupation has been noticeable in the Amazon Forest due to the expansion of agricultural production systems that result in deforestation and environmental impacts. Remote sensing is therefore useful for mapping and monitoring land use and land cover (LULC) in the region. However, quasi-permanent cloud cover makes this monitoring difficult with optical sensors. Synthetic Aperture Radar (SAR) imagery became a successful alternative for mapping LULC in cloudy areas. H/Alpha decomposition is one of the radar techniques that provides the best understanding of polarimetric SAR images. The goal of this study is to assess dual-pol H/Alpha decomposition technique with Sentinel-1A data for mapping LULC in a selected region of the Amazon Forest through Random Forest classifier. In this study, it was evaluated an image acquired in September 2017 by the Single Look Complex (SLC) Sentinel-1A (C-band). The raster image was processed using SNAP prior to the subset selection of the study area; the sub-swaths were de-burst and the precise orbit file was carried out. The multilooking were applied with four looks. Dual-pol H/Alpha decomposition was calculated and a Lee Speckle filter (5x5 window size) was applied. The outputs of H/Alpha decomposition were terrain correct with an Alos-PalSAR DEM, which has 12.5 m of spatial resolution. For LULC classification was used a Random Forest classifier, which requires the definition of two parameters: the number of classification trees (Ntree) and the number of prediction variables (Mtry). In the present study, we used Ntree = 500 and Mtry = 1. The LULC classes analyzed were: Agriculture (AG), Primary Forest (PF), Secondary Succession (SS) and Grassland (GR). Field samples collected in September 2017 were used to validate the results by means of confusion matrix and the Kappa index. We observed that the use of only H/Alpha decomposition showed a global accuracy of 42.1 %, with a Kappa index = 0.17. Analyzing the user's (UA) and producer's accuracies (PA), we noticed that AG class presented the better results, with 54.2 % of PA and 48.4 % of UA. Alternatively, FP and GR classes achieved similar results, with 39.8 % and 38.3 % of UA and 40.6 % and 36.3 % of PA, respectively. The Secondary Succession (SS) class showed the lowest values for UA and PA, with 25.2% and 16.2 %, respectively. We noticed a great confusion between AG and FP classes. This low global accuracy probably is related to the satellite operation band and dual-polarization available, which limits the classification process. In addition, the use of only H/Alpha attributes brought little information to the classifier to influence this result. Other studies in the Amazon rainforest also showed this limitation of the C-band for LULC mapping, mainly in comparison to the L-band.

GOOGLE EARTH ENGINE APPLIED TO LAND COVER MAPPING IN MATO GROSSO DO SUL - BRAZIL

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The mapping and monitoring of land cover contributes to the environmental protection. The image classification is a process of obtaining information where could be noted patterns or similarities to identify an area or target of interest. The supervised training classification approach requires the identification of samples that will be used as patterns or templates to the classes that will compose the entire image classification. The Geospatial Processing Platform Google Earth Engine (GEE) enables fast processing of several images practically in real time. It also possible to edit codes adding different classifiers contained in this platform, and also change them as needed. Allying this tool with remote sensing and machine learning technics, it was performed the image classification in a scene located in southwest region of Mato Grosso do Sul, state of Brazil, with the propose of the land cover mapping. It was intended to verify the capacity to differentiate between native vegetation, eucalyptus crops and agricultural crops. Considering a Landsat 8 OLI Image (2, 3, 4, 5 and 6 bands with spatial resolution of 30 m), samples (approximately 45 polygons) from 8 (eight) classes were collected: native vegetation, eucalyptus crop, pasture, agriculture, water, exposed soil, damp area, and urban area. In all, there were collected 282 training samples and 384 validation points. The training was performed with Random Forest classifier in default mode - 1 (one) decision tree (RF1), and with 10 (ten) decisions trees (RF10) in GEE. The results in general were satisfactory, presenting hit rate or level of success above 90% in all classes, representing a high accuracy differentiation of the classes. The overall training accuracy was above 90%. Small improvements occurred when considering Random Forest with 10 decisions trees. The validation accuracy and kappa index results in values above 85% considering RF1 and RF10. In general, Random Forest classifier distinguished the types of vegetation (native, eucalyptus and agricultural crops) demonstrating the capacity of the classifier for Landsat 8 OLI image classification with the GEE Platform.

ACCURACY ANALYSIS OF TANDEM DIGITAL ELEVATION MODEL IN CAMPO GRANDE/MS

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Digital elevation models (DEMs) are important sources of data for many applications that take into account the relief, hydrography and management of natural resources. There are some free global DEMs, such as: Alos, SRTM and Aster. Tandem is a global paid DEM, presenting higher spatial resolution when compared to the other mentioned DEMs (12 m). There is a lack of studies regarding its accuracy, mainly in Brazil. The main aim of this study is to evaluate the accuracy of the Tandem DEM for the urban area of Campo Grande/MS. Reference data to validate the DEMs were acquired with a dual frequency GNSS, adapted upon a vehicle, in the urban area streets. The GNSS data collected on the streets were downloaded and processed into Inertial Explorer Version 8.30.1007 program, producing 21603 validation points. The GNSS planimetric (latitude and longitude) and altimetric (height) mean standard deviation were approximately 0.10 m and 0.16 m, respectively. The GNSS height is referred to the ellipsoid. TanDEM and ALOS height were compared directly to the GNSS height. To assess the other DEMs, the GNSS height was converted to ortometric height using Brazilian official software - Mapgeo 2015. To obtain the DEMs height regarding to each GNSS point, it was used the QGIS Point sample tools. The height error was estimated using GNSS height (H) and altitude from the DEMs (H DEM). The RMSE and the errors mean and standard deviation were estimated. The analysis of the largest DEM errors showed that there were some discrepancies generated by trees and buildings, which is expected because the GNSS data is referred to terrain data. Were removed 30 points of the urban area of Campo Grande. This follows the recommendations of ASPRS (American Society for Photogrammetry and Remote Sensing) regarding the analysis of altimetric data derived from digital models, in which it is necessary to carry out the control for vegetated and non-vegetated terrain. TanDEM presented the best results with a RMSE 2.87 m. SRTM, Topodata (SRTM mission data processed for Brazil), Alos and Aster presented, respectively, the following RMSE 4.35 m, 4.56 and 7.96. The TanDem proved to be very accurate for the urban area of Campo Grande, when compared to the main global DEMs.

IMPACTS OF CLIMATE AND LAND USE CHANGE ON SOIL EROSION IN THE UPPER PARAGUAY BASIN

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The Upper Paraguay Basin (UPB) integrates parts of the Cerrado and Amazon (highlands) and Pantanal (lowlands) biomes. As the Cerrado has increasingly been replaced by agricultural crops and is currently one of the fastest expanding agricultural frontiers in the world, changes in soil erosion processes are expected. These land-cover and land-use changes (LCLUC) combined with a changing climate may amplify these related sets of impacts. However, there is still a lack of information on how the combination of LCLUC and climate change will affect soil erosion in the UPB. Here, we evaluated the impact of LCLUC and climate change projections on soil erosion across the UPB. We used LCLUC scenarios from the OTIMIZAGRO model and regional climate change models (HadGEM2-ES and MIROC5, RCP 4.5 and 8.5). To compute the average annual soil erosion for the baseline period of 2012 and scenarios for 2015 to 2050, we used the Revised Universal Soil Loss Equation (RUSLE). In total, 64 soil erosion projections were generated, combining LCLUC and climate change scenarios. For the baseline period, we found average annual soil erosion values of 16.73 ± 48 t ha^{-1} yr^{-1} and 17.56 ± 39 t ha^{-1} yr^{-1} using data from HadGEM2-ES and MIROC5, respectively. Our results indicate a significant variation in soil erosion from 2020 to 2050, mainly in the highlands (Cerrado and Amazon biomes). These increases in soil erosion in the Cerrado may compromise the ecohydrological dynamics in the Pantanal in the near future. Therefore, to ensure food-energy-water availability for future generations in the UPB, it is necessary to develop robust and comprehensive planning measures. These measures should consider preventive and adaptation measures for the soil and water conservation, especially for the most sensitive areas found in our study.

FEATURE-BASED MATCHING ASSESSMENT IN OMNIDIRECTIONAL IMAGES FOR CLOSE RANGE PHOTOGRAMMETRY APPLICATIONS.

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Feature-Based Matching (FBM) algorithms have been developed over the years, and extensively tested in perspective images, to meet some requirements, such as accuracy detection, high-repeatability, noise-resistant, high-speed, low computational cost and invariant feature approaches. However, FBM algorithm's performance may change depending on the type of the sensor used. Recently, the use of sensors with non-conventional internal geometry, such as omnidirectional cameras for close range Photogrammetry applications, has motivated the development of image matching algorithms for omnidirectional images. The challenges of these images include non-perspective inner geometry, huge scale variation between scenes, large radial distortion, nonuniformity of spatial resolution and illumination variations. Only a few studies discussed the applicability of conventional interest operators in omnidirectional images. Therefore, the main contribution of our paper are: (1) assess the traditional interest operator's performance for fisheye images acquired on an outdoor environment, (2) identify and analyze the limitation and (3) study some approaches to outcome the identified issue for outdoor close-range application. Thus, two experiments were realized. A preliminary study on the performance of well-known interest operators, with techniques designed for perspective images, such as SIFT, FAST, SURF and MOPS for omnidirectional images were done. Then, based on the result, the operator with superior performance was used in two approaches that aims to extend the results of perspective to omnidirectional image. The first approach converts the wide-angle image into a geometrically corrected perspective image and in the second approach the original omnidirectional image was used combined with a Search Space Reduction (SSR) technique in the sphere domain. A set of fisheye images with a GSD ranging between 2 to 5 centimeters and base varying between 0.75 and 2.25 meters were acquired with a poly-dioptric system named as Ricoh Theta S (1080 x 960 pixels), at an urban area located inside the São Paulo State University campus. From these experiments, SIFT obtained the most successful detection rate among the four operators tested (164 matches) with 70% of correctness. However, this result can change in function of the base geometry and the data set. In general, SIFT performance is 20% reduced for fisheye images in comparison to the performance in perspective images acquired in the same test field. This result illustrates the impact of fisheye image distortion on SIFT efficiency. On the other hand, the number of correct matches tracked by these standard algorithms on omnidirectional image can be very beyond than the minimum number of points required for sensor position estimation. Therefore, the main problems would be to filter non-optimal matches. The accuracy of sensor position estimation is not limited by the number of points considered, but also by the location accuracy, number of consecutive repeated points and distribution of these points in the images, which are problems that remained when the geometric differences between perspective and omnidirectional images are neglected. Then, in the second experiment significant improvements were noticed with the two approaches proposed. An improvement of at least 6 to 15% of SIFT correctness was obtained using a rectified fisheye image or the original image with SSR technique.

ASSESSMENT OF A LIGHT-WEIGHT UAV LASER SCANNING SYSTEM FOR DSM GENERATION

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Airborne LASER Scanning Systems (ALS) enable a fast and geometric data collection of three-dimensional coordinate points from the terrain surface, which can be used for several mapping purposes. For instance, the high pulse penetrability and altimetric accuracy make the ALS a standard technique for dense surface model (DSM) generation. A DSM can be defined as a three-dimensional representation of ground and above ground surface features, such as trees and buildings, being increasingly used for all applications that requires ground elevation information. However, conventional ALS are still a high cost system. Therefore, light-weight system composed by Small Unmanned Aerial Vehicles (UAVs) as a platform (up to 25 kg) with a low-cost LASER unit and the recent miniaturized navigation sensors (positioning and orientation) has become a very feasible and flexible alternative. The DSM quality of LASER data mainly depends on system's precision, data density and data integration and synchronization process, which can provide a centimetric accuracy. Therefore, these light-weight systems combined with a rigorous geometric data process of the LASER unit and the navigation data (GNSS/IMU) can provide satisfactory results for DSM generation. In this regard, this work presents a feasibility study of a light-weight UAV LASER scanning system (≈ 5 kg), focused on the DSM generation. The system proposed consists of a LASER unit, named as Ibeo LUX 2010, a NovAtel SPAN–IGM–S1 (IMU/GNSS), an additional GNSS receiver (NovAtel-FlexPak6) and two microcomputers (Raspberry Pi) arranged in a payload embedded in a Sx8 UAV. LASER and navigation data synchronization can be summarized as a correction of time difference between GNSS receiver and LASER unit. This time difference need to be estimated, aiming to corresponding navigation and LASER unit datasets in the same reference time (GPS time). Therefore, an approach to estimate time differences was developed considering the correlation between normalized LASER distance and normalized GNSS geometric height. Then, UAV-LASER point cloud was generated based on the LASER mathematical model implemented in C++ language, with an average density of 9.93 points/m². The UAV-LASER point cloud accuracy was estimated considering ground control points (GCP) measured with topography techniques (GNSS positioning and Total Station) and with accuracy ranging between 5 to 10 mm. An average altimetric accuracy of 11.6 cm (geometric altitude) was obtained. The UAV-LASER point cloud was used as input data to a DTM (Digital Terrain Model) and DSM generation in the free-software suite LASTools. First, the UAV point cloud was classified into ground and non-ground, considering a filtering by height. Then, low and high outliers were removed and LiDAR heights were normalized. Finally, DTM and DSM were generated (1 m grid). The same process was applied to compute the reference data (DTM and DSM) using a conventional ALS point cloud (RIEGL LMS-Q680i) with a density of 5.8 points/m², from the same test area. The Euclidian distances between DTMs and DSMs were estimated using the least squares local modeling strategy available in CloudCompare. From this set, 80% of the points from the UAV-DSM are less than 37 cm from the ALS-DSM, while the average discrepancy between DTMs was 5 cm. The discrepancy between DSMs can be explained by the environment changing, such as in canopy trees, since data acquisition was performed in different moments. In conclusion, the results show that the products generated from a light-weight system can be an alternative to conventional systems, according to the application.

MACHINE LEARNING APPLIED TO UAV IMAGERY IN PRECISION AGRICULTURE AND FOREST MONITORING

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The Cerrado (Brazilian Savanah) is one of most important biome of South America composing diverse species of fauna and flora, which has an area of 2,036,448 km^2, about 22% of the national territory (Brazil). This biome is composed of several species of trees that are protected by law, which in recent years has been devastated for the charcoal production, such as Garapeira (*Apuleia Leiocarpa (Vog.) Macbr.*), Jequitibá-branco (*Cariniana estrellensis*), Cedro vermelho (*Cedrela Macrocarpa*), Aroeira (*Schinus terebinthifolius*), among others. On the other hand, the country is the second largest soybean world producer and, the State of Mato Grosso do Sul holds the fifth position regarding the national soybean production. However, some insect species such as bed bugs (small oval non-flying insects) and caterpillars have been causing great economic damage in soybean fields. Therefore, Integrated Pest Management is a key factor for the attack control of different species of insects. However, damages caused by both insects are due to the inefficiency or lack of monitoring. The main aim of this proposal, approved by GRSS (Geoscience and Remote Sensing Society) Grand Student Challenge to be presented IGARSS 2019, is to design and implement an end-to-end observing system based UAV to support precision farming and forest monitoring applications. Additionally, a mobile app will be developed to contribute to the precision farming and forest monitoring applications. The UAV already developed has frame of 800 mm, carbon propellers 15" and motor with 390 Kv. In addition, a preliminary mechanism to support the camera, made of aluminum and 3D parts, was developed. Computational vision techniques, using machine learning, will be used to develop the software that will perform the automatic: a) counting and identification of the soybean pests species; b) mapping of law protected tree species; and c) 3D forest modeling in permanent preservation areas. Both algorithms are going to use a bank of images of the main insects-plagues of the soybean crop and tree species from Cerrado (the tree of study will be the Cumbaru – *Dipteryx alata*), however the bank will contain more than 2000 images. It is expected that the achieved results support both precision agriculture and forest applications, returning faster and more accurate results. The obtained results will also support similar research fields and serve as base in several other applications. Finally, a GRSS student chapter will be created promoting integration among institutions.

MULTITEMPORAL ANALYSIS OF LAND COVER AND ITS INFLUENCE ON FEDERAL HIGHWAY BR-163 INFRASTRUCTURE

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The federal highway BR-163 in the southern of Mato Grosso do Sul has suffered frequent disruptions due to floods, causing interdictions. Interruptions in the highway generate delays and losses in terms of product and logistical increase in the production flow and storage. BR-163 is responsible for transit and communication between cities and other states of the country, which depend directly from its flow to the economy, urban mobility and social assistance of the local population. The objective of this work was to investigate the influence of soil cover changes on the floods/interdictions of the southern region (Dourados-Mundo Novo – 49 km hydrographic basin) of BR-163, in the state of Mato Grosso do Sul. Landsat 8 satellite images from different dates (03/02, 03/18, 05/05, 06/06, 06/22, 08/09, 10/28, 11/13/2015 and 03/20/2016) were used, and two classification algorithms in GEE (Google Earth Engine) were considered: Random Forest and SVM (Support Vector Machine). The following classes were considered: forest, crop, exposed soil and pasture. The results obtained with the Random Forest classifier presented superior results when compared to SVM, with overall accuracy arithmetic mean of the 98.6% in the nine experiments, while SVM presented only 84%. Also, the SVM was not able to classify the eighth experiment (11/13/2015), because the image contains lot of clouds, but the another was able with 95,7% of overall accuracy. In addition, it was verified visually that the Random Forest classifier differentiate classes more accurately detailing the changes in each image used. It was verified that one of the factors that contributed to the interruption occurred on December 12, 2015 was the change in soil cover. The increase of exposed soil implies greater erosion, because the soil does not absorb rainwater, so the amount of sediment deposition in the watercourse is higher. Therefore, the more sediments that are drained, the more the highway drainage system (culverts) obstructs the flow, causing flooding and the interdiction of vehicles circulation. In addition, the accumulation of water resulting from the clogging caused a gully erosion.

THE APPLICATION OF GIS IN THE IMPLANTATION AND MANAGEMENT OF CONSERVATION IN THE BODOQUENA PLATEAU, MATO GROSSO DO SUL

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The Geographic Information Service (GIS) was applied in the present work to contribute to the analysis of the landscape, location, land use and land cover and implemented geographic and landscape information for the implementation of the Management Plan of the Conservation Unit (CU) in a rural property located in the Bodoquena Plateau. This work was carried out by the Graduation Teaching Project of the Environmental Management course by the Federal University of Grande Dourados (UFGD) entitled "Protected Areas in Mato Grosso do Sul, evaluation and decision making". In 1999, a Private Natural Heritage Reserve (PNHR) was implemented in Jardim, in the Bodoquena Plateau, in the state of Mato Grosso do Sul, specifically on the Fazenda Rio da Prata (Silver River farm). The idea was to increase its financial income, conserving and preserving the natural resources in 21% of the area and making use with controlled impact in its ecotourism activities to be implemented and livestock already existing at the time. The application of GIS was useful in almost all the PNHR and for its current management, which identified wetlands, watercourses, native vegetation, degraded areas and declivity, which allowed the decision making to implement ecotourism and livestock activities. The PNHR presents an area of 307 hectares with diversity of environments, presenting two rivers of crystalline waters, rich biological diversity, scenic and ecosystemic and economic services. The PNHR protects the Rio Olho d'Água (river Eye of water) the integral form and the right bank of the Rio da Prata (River of Silver). In order to map and identify the use and occupation of the soil, the aid of the Quantum Gis Desktop 2.18.20 witch GRASS 7.4.0 program was applied using the Shuttle Radar Topographic Mission (SRTM) data and the Watershed tool for the delimitation of micro catchments, assistance of a GPS model GARMIM 76 CSX for CU. The Management Plan follows specific rules and restrictions according to the ecological characteristics of the unit. A rapid environmental assessment was applied and showed ownership as a reference in conservation activity, nature tourism and environmental management. In 2017, more than 36 thousand tourists visited the property, 30% were foreigners, generating an income of about R$ 8.2 million that same year. The application of the GIS was fundamental for the elaboration of the Management Plan and for the current management of the rural property referred to with thematic maps and satellite images, allowing the proper study of the landscape. After the implementation of the PNHR, the job offer presented a significant increase, besides integrating ecotourism with sustainable livestock, benefiting the environment and the resident population.

CATTLE SEGMENTATION USING UAVs SUPPORTED BY COMPUTER VISION TECHNIQUES: PRELIMINARY RESULTS

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We can list some applications of systems based on interpretations of images captured by UAVs (Unmanned Aerial Vehicle) as support for precision livestock farming. Among them we highlight the counting of cattle heads for inventory and other purposes, tracking, identification and slaughter point estimation. These applications can be supported by computer vision techniques, however, some approaches work with the entire captured image without separating the object of interest from other objects in the image, hence processing noise leading to undesired performance. Separating objects of interest into images can improve the performance of applications, since errors caused by noise are discarded. In this sense, we propose an approach to segment cattle in feedlot batches, through images acquired by UAVs using computer vision and machine learning techniques. For this, we used aerial images captured with a DJI Phantom 4, the height of 20 meters in a flight that resulted in a set of 101 images of an experimental confinement installed in the Fazenda Escola of UFMS/FAMEZ. The animals were arranged in individual paddocks with a structure equipped with feeders and water through, totaling 22 Nellore cattle. We segment captured images using the Simple Linear Iterative Clustering (SLIC) algorithm, configured to segment the image into 850 segments,

Gaussian kernel diameter at 5.0 and compactness, which balances the proximity of color and space to 10. The pixels grouped by the SLIC formed superpixels totaling 202 segments. We visually classify superpixel segments of an image into two classes: bovine and background. As background were considered fences, troughs, drinking fountain, land and grass regions. After classifying the superpixel segments we extracted the characteristics of each of them using the descriptors of Histogram of Oriented Gradients (HOG), Hu's Moment Invariants, Gabor Filter (GFs), Local Binary Patterns (LBP), Gray Level Co-occurrence Matrix (GLCM) and information in the RGB, HSV and CIELAB color spaces. The characteristics extracted from the superpixels were submitted as input to the K-Nearest Neighbour hood (KNN), Support Vector Machines (SVM), Decision Trees (J48) and AdaBoost machine learning algorithms with the WEKA 3.8.2 standard parameters . We performed training and testing on the extracted data and used the 10-fold cross-validation to obtain the metric precision, with the same number of bovine and background images. We obtained the highest precision with the KNN algorithms (k = 1) with 97.02%, followed by SVM and AdaBoost, both with 94.55%. The worst accuracy was achieved with the J48 algorithm with 92.57%. Although this experiment characterizes the initial stage of segmentation of cattle in images captured with UAVs, we believe that the presented results are encouraging and may support other researchers to develop several softwares whose process needs to identify the bovine as main object in this type of image. In addition, stimulate new approaches such as KNN with other K values, validate results by means of segmentation metrics among others. Finally, to explore the use of computer vision and machine learning to segment cattle in aerial images.

UAV APPLIED TO THE ESTIMATION OF DIAMETER AT BREAST HEIGHT (DBH) ROADSIDE TREES

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The management of the clear zone is a major factor in the field of road safety, especially when there is large vegetation near the roadway. Studies show that approximately 60% of off-piste collisions, with fixed elements, have trees as obstacles. The volumetric calculating characteristics of arboreal individuals is critical information to identify these large trees. The conventional procedure is to measure in the field the diameter at breast height (DBH) and the height of the trees, the latter usually estimated. This procedure is usually time-consuming, expensive and sometimes prohibitive in long roads. While numerous studies have been done on UAV-based photogrammetry techniques, few studies have been done on the estimation of volumetric characteristics of roadside trees. We propose a procedure to estimate the DBH of the trees that are close to the highways using drone images reaching an acceptable accuracy. The proposed procedure will bring speed and economy to surveys on roadsides obstacles, which by consequence can improve the road safety. Our proposal also opens new possibilities such as that of revisiting the images, to promote studies in the sense of making better use of the woody material to be generated. In this first phase, oblique images were taken from the flight of a drone, equipped with a conventional digital camera, which presented omega angle between 75 and 85 degrees. The oblique images reached 3 columns of trees, with 3 individuals each. Next, using the software Pix4D, we measure the DBH using the computed point clouds. In this way, it was possible to measure the first row of trees. Measuring the furthest trees is one of the challenges to be overcome. Measures of DBH collected in the field were compared with the measurements obtained through the point clouds, at first, with the processing without the use of ground control points (GCPs) and then with their use, in a total of 4 GCPs. The results point to a better accuracy in the data coming from the processing with GCPs, with the root mean square error (RMSE) of 2.8 cm against 5.7 cm without the use of the GCPs, and the correlation between measured and estimated DBH was 98% and 96.3%, respectively. These preliminary results are very encouraging. However, several tests will still be necessary to overcome challenges such as cloud generation of the required bandwidth and automation of DBH.

UNSUPERVISED REPRESENTATION LEARNING FOR CLASSIFICATION OF REMOTE SENSING IMAGES BASED ON GENERATIVE ADVERSARIAL NETWORKS

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Deep Learning (DL) techniques have recently become very popular for remote sensing (RS) image analysis. Supervised DL approaches involve multilayer networks that learn abstract and discriminative semantic features, and also perform classification. However, the number of parameters to be learned and, consequently, the demand for labeled training samples increases with the number of network layers. Deep networks involving hundreds of thousands of parameters are not uncommon. In RS field, the collection of labeled patterns is time-consuming and costly. Due to the scarcity of ground-truth information, developing and evaluating supervised DL architectures for land-cover/land-use classification become challenging. In this context, unsupervised methods may be a more practical alternative. They seek to exploit the wealth of unlabeled RS data for feature extraction and to convert raw data into meaningful information. Among the unsupervised DL approaches, the so-called Generative Adversarial Networks (GANs) have attracted great interest within the machine learning community in the last few years. In these networks, two models are trained simultaneously: a generative model G, that captures the input data distribution and generates samples from it, and a discriminative model D, that estimates the probability that a sample comes from the input data or has been produced by the generator G. This paper compares two approaches inspired on GANs for unsupervised feature learning. In the first one, the generator receives a noise vector as input and produces a synthetic image. The generator architecture is composed of six deconvolutional layers and the discriminator is composed of six convolutional layers, both networks use a kernel size of 5x5. In this case, the model uses features learned by the discriminator. In the second approach, the generator receives a real image as input and produces a synthetic image too. In contrast to the previous approach, the generator is composed of two stages, the first one is an encoder with six convolutional layers, and the vector obtained from this stage is the input of the second one, which is a decoder with six deconvolutional layers using a kernel size of 5x5. The discriminator maintains the same architecture as the first approach, but in this case, the features are learned from the first stage of the generator. Both approaches were evaluated experimentally upon the UC-Merced Land Use dataset, which consists of images comprising 21 land-use classes. An SVM classifier was used to evaluate the quality of the representations learned by both architectures. For training and testing the GAN were used 6720 and 420 images respectively, which were obtained using a data augmentation from the original database. Likewise, the same sets were used for the SVM classifier. The experimental results revealed the superiority of the features derived from the discriminator in terms of overall accuracies, which achieved 94,99% of accuracy in contrast to 74,04% obtained from the second approach.

A BRAZILIAN ACADEMIC PANORAMA ON THE USE OF RPAS TO REMOTE SENSING AND PHOTOGRAMMETRY

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This paper aim to quantify key aspects on Brazilian scientific literature of the use of RPAS for obtaining photogrammetry and remote sensing data, focusing on the understanding of the products and services generated, as well as on the methods and equipment used by the authors. A systematic bibliographical review was done on digital platforms of data search, during the month of April 2018; by combination of the terms "MONOGRAPHY, DISSERTATION, THESIS, RPA, DRONE, UAV, PHOTOGRAMETRY, REMOTE SENSING", selecting works published by Brazilian institutions; with cut line of 10 years (2008 limit year) of monographs of doctoral theses; master's theses and end-of-graduation publications. Thirty-six (36) relevant academic works have been identified, in which were evaluated the presence or absence of eleven (11) Boolean parameters related to the products generated and methods used and, also eight (8) Qualitative parameters to characterize the type, the area and the RPAS equipment used on the publication. Monographs of all regions of Brazil were reviewed, 12 of which were from the Southeast region (33.33%); 8 from the South region (22.22%); 8 from the Center-West region (22.22%); 7 from the Northeast region (19.44%) and 1 from the North region (2.78%). The diversity of the areas of the monographs highlights Cartography (6 monographs); Geography (6 monographs); Civil Engineering (4 monographs); Forest Engineering (3 monographs) and Environment Science (3 monographs) with more than 60% of the reviewed publications (22 monographs). The main applications of the monographs, grouped in six (6) classes, show that most of the authors (~ 33.0% of the reviewed monographs) concentrate their efforts on studies for the generation and verification of digital surfaces and land models (MDT / MDS); followed by studies to perform inspections (~ 19.0% of the total review). Studies that used RPAS for mapping and classification of vegetation cover and those that presented data generation and application on a cadastral cartographic scale (1 / 10,000 or greater) had the same amount of work reviewed (total of ten monographs, ~ 28.0%). Four monographs (~11.0%) presented studies to verify the quality of the products generated and the systems used while other three monographs (~ 9.0%) could not be classified in the other groups. The research indicates that there are no monographs of RPAS that have been controlled by a GNSS receiver RTK (Real Time Tracking) and that, in cases where they were made Mappings of Corridors, the extension of the surveys did not exceed 5 km of extension. The studies that evaluate the cartographic quality of the generated products are not conclusive, since it is not possible to verify a consistency in the methodologies of the analyzes carried out by the authors. There are indications that the quality would not exceed 'Class B', on scales 1 / 10,000; with products similar to those generated by authors who classified as 'Class A' (PEC-PDC) scales from 1/1000 to 1/2500.

EVALUATION OF RIGOROUS AND GENERALIZED MODELS IN GEOMETRIC CORRECTION OF CBERS-4 / PAN IMAGES

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The use of remote sensing has become an indispensable tool for the monitoring of the Earth's surface and numerous applications in the context of Earth observation. The Earth observation satellites have embedded sensors that provide orbital images that require different levels of detail and positional accuracy. The China-Brazil Earth Resources Satellite Program (CBERS) program was originated from a partnership between Brazil and China in the technical-scientific spatial sector. The CBERS-4 satellite is the fifth satellite of the CBERS Program and contains the PAN sensor, which collects panchromatic images with spatial resolution element (GSD - Ground Sample Distance) of 5 m and multispectral images with GSD of 10 m. The researches related to the analysis of positional reliability and geometric correction of CBERS-4 images are still limited. In addition, some studies have shown that the georeferenced images of the CBERS-4 / PAN sensor showed significant positional displacement. Due to the positional displacement being incompatible with GSD, this work aims to evaluate the rigorous and generalized mathematical models in the geometric correction of CBERS-4 / PAN images, where different methods will be applied to the geometric correction of the images using points. Images with different levels of previous correction (levels 1 and 2) were considered. Level 1 images are derived only from the application of radiometric calibration procedures, while level 2 images are level 1 images geometrically corrected from satellite orbital data information. The mathematical models for the process of geometric correction relate the object space (terrestrial reference system) and the image space. Generalized models have the advantage of not requiring knowledge of the system acquisition parameters, such as focal length, sensor size, among others. However, the generalized models require a significant amount of ground control points (GCPs) with uniform distribution throughout the image. The following generalized models were adopted: Polynomials of order 1, 2 and 3; Projective and; Thin-plate spline (TPS). Rigorous models aim to describe the scene acquisition geometry from sensor and platform model information. The rigorous mathematical models used to orient orbital images are usually based on the collinearity condition (Collinearity Model with Points and Collinearity Model with Points using Orbital data), which uses points to relate the object and space images. In addition, mathematical models based on linear features (Line Coplanarity Model and Line Coplanarity Model with Orbital data) can also be used. The geometric correction validation was performed from the RMSE (Root Mean Square Error) at checkpoints, where results have already been obtained using generalized models. The second order Polynomial provided the best results among the generalized models with RMSE around 2 GSD. The next step is to get results from applying the rigorous model, and then compare the results between the models, and thus get products with high positional accuracy where could be used in diverse applications.

PERFORMANCE EVALUATION OF THE PIX4DMAPPER SOFTWARE TO GENERATE SURFACE REFLECTANCE VALUES OF MULTIESPECTRAL IMAGERY ACQUIRED BY THE PARROT SEQUOIA CAMERA

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The Pix4Dmapper software is frequently used to generate the surface reflectance values of imagery taken by unmanned aerial vehicles (UAVs). Nonetheless, it is necessary to investigate the accuracy of the method used by the software. This work aims to evaluate the performance of the Pix4Dmapper to correct multispectral images obtained by an Ebee RTK model with a Parrot Sequoia multispectral camera, with green, red, red-edge and near infrared bands. Therefore, we compare imagery corrected in surface reflectance values using the Pix4Dmapper software with terrestrial data measured by a field spectroradiometer. The study area consists of an orchard of orange trees of different species. An orthomosaic was composed with multispectral images obtained by the Parrot Sequoia camera during a field campaign, on a sunny day with stable atmospheric conditions. The flight height was around 120 meters. The Sequoia data was process in the Pix4Dmapper software, were we obtained the reflectance values of each band. In conjunction, spectral curves were simulated based in the sensor response function while considering each band of the Sequoia camera using the leaf radiance measured by an ASD FieldSpec HandHeld spectroradiometer. This equipment operates in the spectral range of 375–1075 nm, set on 512 channels with 1.6 nm spectral resolution and a Field of View (FOV) of 10°. We measured ten spectral curves of 23 orange trees and used their averages values. For each tree measurement, the radiance of a Lambertian reference surface (Spectralon® plate) was also measured under the same conditions of illumination and observation to estimate the Hemispheric Conical Reflectance Factor (HCRF) of the leaf. The spectroradiometer was positioned at an angle of 45° and at an average height in relation to the orange tree. All of the 23 orange trees were located using a navigation Global Positioning System (GPS), and were identified into the multispectral imagery. For each band, we calculate the discrepancy and the Root Mean Square Error (RMSE) between the reflectance values obtained by the Pix4Dmapper correction and the simulated reflectance data. The reflectance values of each point did not present a normal probability distribution, thus a nonparametric statistical test was applied. The discrepancy (and the RMSE) between values were 0.0042 (RMSE = 0.0604) for the green (band 1), 0.0239 (RMSE = 0.0446) for red (band 2), 0.0165 (RMSE = 0.2706) for red-edge (band 3) and 0.0924 (RMSE = 0.3563)

for near infrared regions (band 4). The Mann-Whitney test results showed that there is no difference between the reflectance values obtained by the simulated values and the Pix4Dmapper correction for the green (p = 0.5828), red-edge (p = 0.4958) and near infrared (p = 0.5828) bands. However, we found a significant difference for the red band (p= 0.0014). We adopted a confidence level of 95%. We conclude that, except for the red band, the procedure to convert digital number to reflectance performed by the Pix4Dmapper to correct imagery from the Parrot Sequoia camera is consistent with the approach to simulate spectral curves using data of a spectroradiometer. Therefore, multispectral imagery obtained with the Parrot Sequoia camera, corrected by Pix4Dmapper, provides a precise radiometry data.

Keywords: Radiometric evaluation; Atmospheric correction; Photogrammetry.

REMOTE SENSING APPROACHES TO DETERMINE THE COVER AND MANAGEMENT FACTOR OF RUSLE

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The land-cover and management factor (C-factor) is one of the most complex to obtain of all Revised Universal Soil Loss Equation (RUSLE) factors. It represents how coverage, land use and land management influence the magnitude of soil losses. In this study, a correction factor is proposed for C-factors obtained by remote sensing (satellite imagery such as Landsat-8). For this, three ways to calculate C-factor were compared: (I) from literature values, and from remote sensing, applying the (II) Van der Knijff et al. (1999) equation and (III) Durigon et al. (2014) equation. The influence of these calculated factors on the soil loss estimation by RUSLE and on the sediment yield estimation (SY) was also assessed. To better evaluate and validate our estimations, we compared data from estimated SY and monitored production of sediment in the Córrego Guariroba basin, in the Brazilian Cerrado. The proposed correction factor is a multiplicative value of 0.1 applied to each generated C-factor map. The mean values of C-factor found were 0.2126, 0.023 and 0.014 for (I), (II) and (III), respectively. The mean soil loss for corrected (I), (II) and (III) were 1.53 ± 17.2 t.ha-1.year-1, 1.44 ± 4.78 t.ha-1.year-1 and 0.77 ± 3.0 t.ha-1.year-1. The estimation of SY were 4.520 t.year-1, 4.254 t.year-1 and 2.275 t.year-1 for (I), (II) and (III), respectively. With the application of the correction factor, soil loss and SY estimation presented similar values between (I) and (II). Therefore, the methodology is designed so that the results are not only for qualitative purposes but can be used quantitatively in soil loss and sediment production estimates.