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2019 Data Fusion Contest

The 2019 Data Fusion Contest, organized by the Image Analysis and Data Fusion Technical Committee (IADF TC) of the IEEE Geoscience and Remote Sensing Society (GRSS), the Intelligence Advanced Research Projects Activity (IARPA), and Johns Hopkins University (JHU), aims to promote research in semantic 3D reconstruction and stereo using machine intelligence and deep-learning techniques applied to satellite images (Figure 1). The objective is to reconstruct both a 3D geometric model and a segmentation of semantic classes for an urban scene. Incidental satellite images, airborne lidar data, and semantic labels are provided to the community. As in previous years [1], [2], the contest will be set up as a benchmark competition. Four different tasks are evaluated in four parallel and independent competitions:

- *track 1*: the single-view semantic 3D challenge
- *track 2*: the pairwise semantic stereo challenge
- *track 3*: the multiview semantic stereo challenge
- *track 4*: the 3D point-cloud classification challenge.

We distribute urban semantic 3D (US3D) data, a large-scale public data set with multiview, multiband satellite images and reference geometric and semantic labels for two large cities [3]. The US3D data set covers approximately 100 km^2 over Jacksonville, Florida, and Omaha, Nebraska. For the contest, we provide training and test data sets for each challenge track, including approximately 20% of the US3D data. Incidental satellite images consist of WorldView-3 panchromatic and eight-band visible and near-infrared (VNIR) images (provided courtesy of DigitalGlobe), collected between 2014 and 2016, with a ground sampling distance of approximately 35 cm and 1.3 m for panchromatic and VNIR images, respectively (see Figure 2). Airborne lidar data come from the Homeland Security Infrastructure Program, and the aggregate nominal pulse spacing is approximately 80 cm. Training data derived from lidar include reference data above-ground-level height images for track 1, disparity images for track 2, and digital surface models for track 3. Semantic labels derived from the lidar products are released as semantic maps for tracks 1–3 and semantic point clouds for track 4. Classes comprise buildings, elevated roads and bridges, high vegetation, ground, water, and so on.

In track 1, single-view semantic 3D, an unrectified single-view image is provided for each geographic tile. The objective is to predict semantic labels and above-ground heights. In track 2, pairwise semantic stereo, a pair of epipolar rectified images is given, and the objective is to predict semantic labels and stereo disparities. In track 3, multiview semantic stereo, the goal is to predict semantic labels and a digital surface model given several multiview, unrectified images associated with a precomputed geometry model to focus on the data fusion problem and not on registration.

IN TRACK 4, 3D POINT-CLOUD CLASSIFICATION, THE AIM IS TO LABEL POINTS FROM THE GIVEN AERIAL POINT CLOUD ACCORDING TO SEVERAL PREDETERMINED SEMANTIC CLASSES.

For tracks 1–3, performance is assessed using the pixel-wise mean intersection over union (mIoU), for which true positives must have both the correct semantic label

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and a height error lower than a given threshold (1 m for heights or three pixels for disparities). We call this metric *mIoU-3*. Finally, in track 4, 3D point-cloud classification, the aim is to label points from the given aerial point cloud according to several predetermined semantic classes (see Figure 3). For this track only, performance is assessed using standard mIoU.

This year, the Data Fusion Contest centers on a topic of growing importance: 3D Earth observation. It raises several difficult issues, such as high-resolution 3D reconstruction from space and large-scale understanding of 3D data. Fortunately, it attracts the interest of people working in very diverse fields, from remote sensing and machine learning to computer vision and computer graphics. The benchmark we propose will enable evaluation of the best approaches for these tasks. Moreover, we distribute an unprecedented amount of training data (sampled from more than 100 km^2, for a total of more than 300 GB of data), which allows for

FIGURE 1. The logo for the 2019 IEEE GRSS Data Fusion Contest.

FIGURE 2. Raster data involved in the 2019 Data Fusion Contest: (a) and (b) two very-high-resolution satellite images for stereo correspondence, (c) a stereo disparity map, and (d) a semantic 2D map.

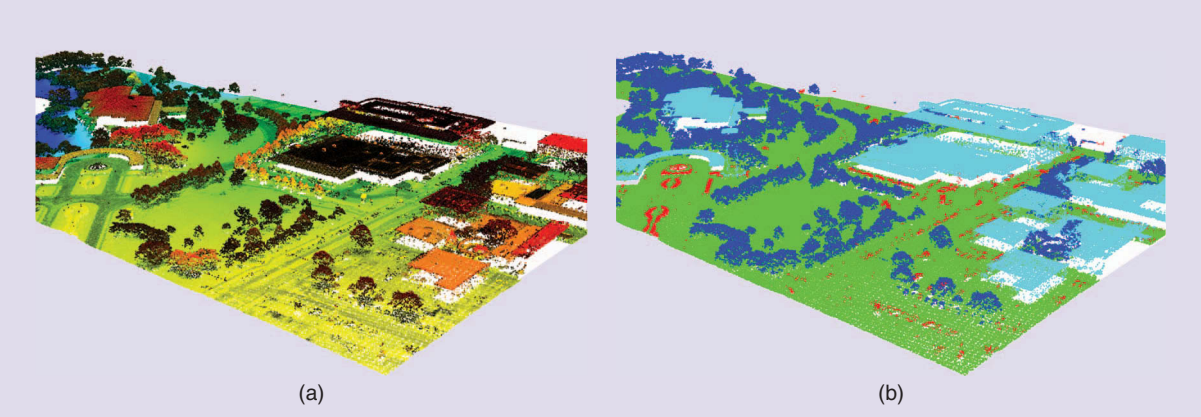

FIGURE 3. Point-cloud data involved in the 2019 Data Fusion Contest: (a) airborne lidar point-cloud and (b) semantic 3D point-cloud cartography.

training in today's powerful statistical learning algorithms. In particular, we introduced a track for 3D estimation from a single image, a task that would have seemed out of reach without the recent advances in deep learning.

GET THE DATA, AND ENTER THE CONTEST

The 2019 Data Fusion Contest is cast as a three-phase benchmark. It started on 7 January with the release of training data (with reference labels) and evaluation data (without reference) to allow participants to elaborate their best strategy and train their algorithms. One month later, on 7 February, the evaluation server opened to let participants measure their performances on the evaluation data and rank themselves in a public leaderboard. The definitive test phase is currently in process: on 7 March, we released the final test data, and participants have until 22 March to submit 3D semantic maps along with a short description of their approach.

To register for the contest and download the data, participants visit the IADF TC website (http://www.grss-ieee.org/community/technical-committees/data-fusion/data-fusion-contest). There, they get information about how to proceed, links to download the data, and access to the evaluation server. They are required to read and accept the contest terms and conditions. Questions and comments about the data and the contest can be submitted to the LinkedIn group of the IADF TC (http://www.grss-ieee.org/community/technical-committees/data-fusion/data-fusion-contest/).

AWARDEES, AWARDS, AND PRIZES

This year, eight teams will receive awards: the winner (best-ranked submission) of each track and the second-best team of each track. They will be invited to submit a manuscript to the 2019 IEEE International Geoscience and Remote Sensing Symposium (IGARSS) in Yokohama, Japan, formatted according to the standard guidelines and templates. It will describe the method used to enter the Data Fusion Contest and the results. All eight papers will be presented by the winners in a long invited session dedicated to the outcome of the contest at IGARSS 2019. They will also be included in the technical program and in the IGARSS 2019 proceedings. The winning teams will receive their awards in July 2019 at IGARSS 2019. The awards are as follows:

- The four winners and four second-ranked teams will present their papers in the 2019 Data Fusion Contest invited session.
- The same four winners and four second-ranked teams will be awarded an IEEE Certificate of Recognition. The awards ceremony will take place at the Technical Committee and Chapter Chairs' Dinner at IGARSS 2019.
- The four winners (first-ranked result in each track) will also be awarded a special prize.
- The three winners of tracks 1, 2, and 3 will coauthor an article that will summarize the outcomes of the contest concerning semantic 3D reconstruction from space, which will be submitted to *IEEE Journal of Selected Topics in Applied Earth Observations in Remote Sensing* (*JSTARS*).
- The winner and the second-ranked team of track 4 will coauthor an article that will summarize the outcomes of the contest concerning semantic 3D point-cloud classification, which will be submitted to *JSTARS*.

For both journal articles, a maximum of three authors per team will be included. To maximize impact and promote the potential of current multisource remote sensing technologies, the open-access option will be used for these submissions. The GRSS will cover the costs related to the open-access fees and to the winning teams' participation in the Technical Committee and Chapter Chairs' Dinner at IGARSS 2019. It will also sponsor the prizes for the winning teams.

THIS YEAR, THE DATA FUSION CONTEST CENTERS ON A TOPIC OF GROWING IMPORTANCE: 3D EARTH OBSERVATION.

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