Technical Report: Scene Labeling Ground Truth Map for MUUFL Gulfport Data Set

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ABSTRACT

This report presents the documentation of the ground truth map for MUUFL Gulfport data set campus 1 scene, provided by manually labeling the pixels in the scene into trees, mostly-grass ground surface, mixed ground surface, dirt and sand, road, water, buildings, shadow of buildings, sidewalk, yellow curb, cloth panels (targets), and unlabeled points. This report also provides plots of each sub-class labels and explains information contained in the MATLAB structure.

1 MUUFL Gulfport Data Set and Labels

The MUUFL Gulfport data set[1] was collected in Novemeber 2010 over the campus of the University of Sourthern Mississippi-Gulfpark, located in Long Beach, Mississippi. The data collection contains co-registered hyperspectral and LiDAR data over the campus. Detailed data description can be found in [1].

This report presents the documentation of the pixel-based ground truth map for MUUFL Gulfport hyperspectral data collection - campus 1 scene. The ground truth map was provided by manually labeling the pixels in the scene into the following classes in the scene: trees, mostly-grass ground surface, mixed ground surface, dirt and sand, road, water, buildings, shadow of buildings, sidewalk, yellow curb, cloth panels (targets), and unlabeled points. Google Maps[2], Google Earth[3] and geo-tagged photographs at the scene were used to assist the labeling process.

The original MUUFL Gulfport data set campus 1 scene contains 325×337 pixels across 72 bands. Due to noise, the first four and last four bands were removed, resulting in a new hyperspectral image of 64 bands. The lower right corner of the original image contains invalid area, thus only the first 220 columns were used for the ground truth mapping. The size of the cropped hyperspectral imagery is $325 \times 220 \times 64$. Figure 1 shows the RGB image of the new data set (campus 1 scene) used for ground truth mapping.

Figure 2 shows the high-level labels for each of the following twelve class in the scene: trees (label "1"), mostly-grass ground surface (label "2"), mixed ground surface (label "3"), dirt and sand (label "4"), road (label "5"), water (label "6"), buildings (label "7"), shadow of buildings (label "8"), sidewalk (label "9"), yellow curb (label "10"), cloth panels (targets) (label "11"), and unlabeled points (label "-1"). Specifically, "mostly-grass ground surface" class refers to ground surface that are visually identifiable as covered in grass, while "mixed ground surface" class refers to ground-covering materials that may contain grass but may also contain soil, dirt and any other surface material. Cloth panels with various spectral characteristics were placed in the scene to construct super-pixel and

[1]The MUUFL Gulfport Hyperspectral and LiDAR Data Collection Files can be downloaded here: https://github.com/GatorSense/MUUFLGulfport. Geo-tagged Photographs and Ground-truth locations of this scene tagged in a GoogleEarth KML can be downloaded here: https://github.com/GatorSense/MUUFLGulfport.

[2]https://www.google.com/maps

[3]https://www.google.com/earth/

Figure 1: Cropped MUUFL Gulfport campus 1 hyperspectral imagery RGB image.

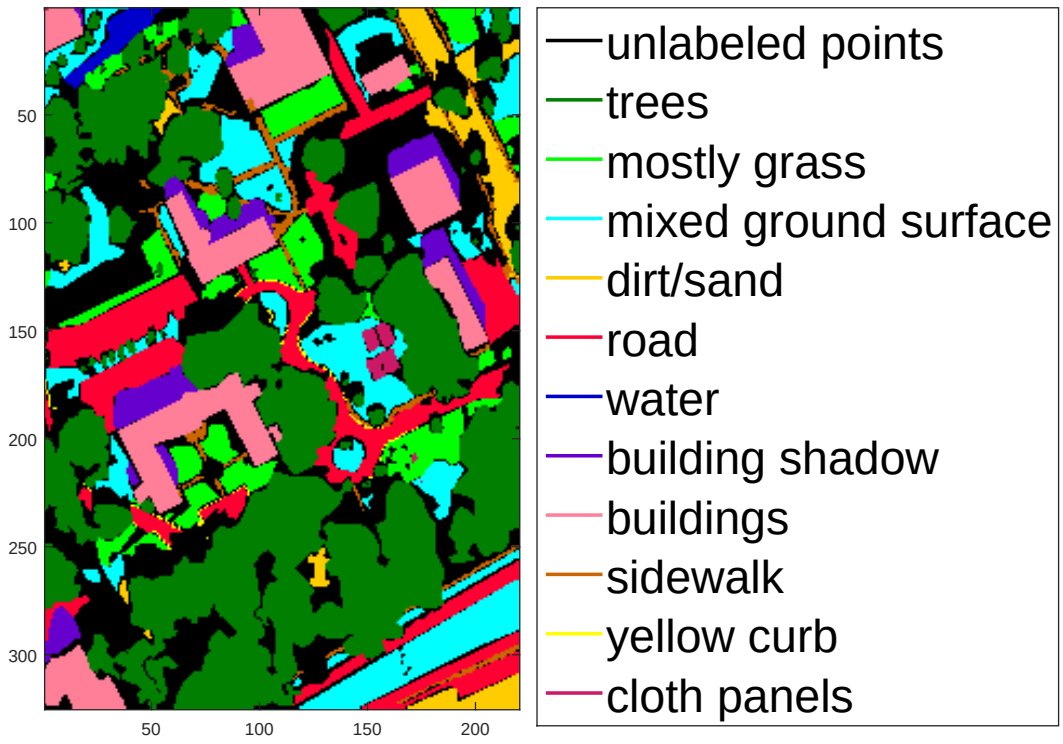

Figure 2: MUUFL Gulfport campus 1 hyperspectral imagery scene labels ground truth map.

sub-pixel targets [1], only those that are larger than pixel-level and visually identifiable are labeled separately into "cloth panels" class. All other class may contain sub-pixel cloth targets. This new cropped data set consists of fifty cloth panels. Specific target groundtruth locations can be found in the label MATLAB structure file. All points that are un-identifiable as any of the first eleven classes are labeled as "unlabeled points".

2 Sub-Class Labels

This section provides sub-class labels for the following classes: buildings, mixed ground surface, dirt and sand, road, and shadows. These classes are visually identifiable to contain mixed materials and

are therefore provided with more detailed sub-class labels. For all following images in this section, white color refers to other classes than the one under investigation and specific colors correspond to sub-classes. Materials from one sub-class usually have distinct spectral signature from another sub-class material, thus making it necessary and helpful for users to choose from those more specific sub-classes if users desired to conduct classification based on spectral information.

Figure 3 shows the sub-class labels for "buildings" class, including light-grey roof, medium-grey roof, dark-grey roof, red roof, red roof in shadow, yellow roof, white roof, white roof in shadow and unlabeled rooftop pixels. The different roof colors corresponds to different materials with distinct spectral signatures. Figure 4 shows the sub-class labels for "dirt and sand" class, including dirt road, bare ground (soil-type ground-covering materials), and beach sand (bright white sand by the beach). Figure 5 shows the sub-class labels for "mixed ground surface" class, including all other mixed ground surface (mostly identifiable as dirt and any other ground-covering materials but mixed with some grass) and freeway median. Note that the pixels in this class all contain some portion of mixed grass and vegetation and the "beach and sand" class does not. Figure 6 shows the sub-class labels for "road" class, including asphalt and gravel roads. Both sub-classes correspond to road materials but have distinct spectral signatures. Figure 7 shows the sub-class labels for "shadow of buildings" class, where the shadows may fall on asphalt or fall on grass, leading to distinct spectral signatures.

3 MATLAB File ReadMe

This section explains the MATLAB file for the scene labeling ground truth data in detail.

The MATLAB file, "$muufl\_gulfport\_campus\_1\_hsi\_220\_label.mat$", provides a structure, "hsi", that contains detailed information for the scene labeling ground truth data. Table 1 provides descriptions on all the fields inside the structure.

Specifically, "hsi.sceneLabels" is the structure that contains the scene labeling ground truth maps, including high-level labels and sub-class labels. The high-level material types (classes for labeling) includes trees, mostly-grass ground surface, mixed ground surface, dirt and sand, road, water, buildings, shadow of buildings, sidewalk, yellow curb, cloth panels (targets). All the pixels in

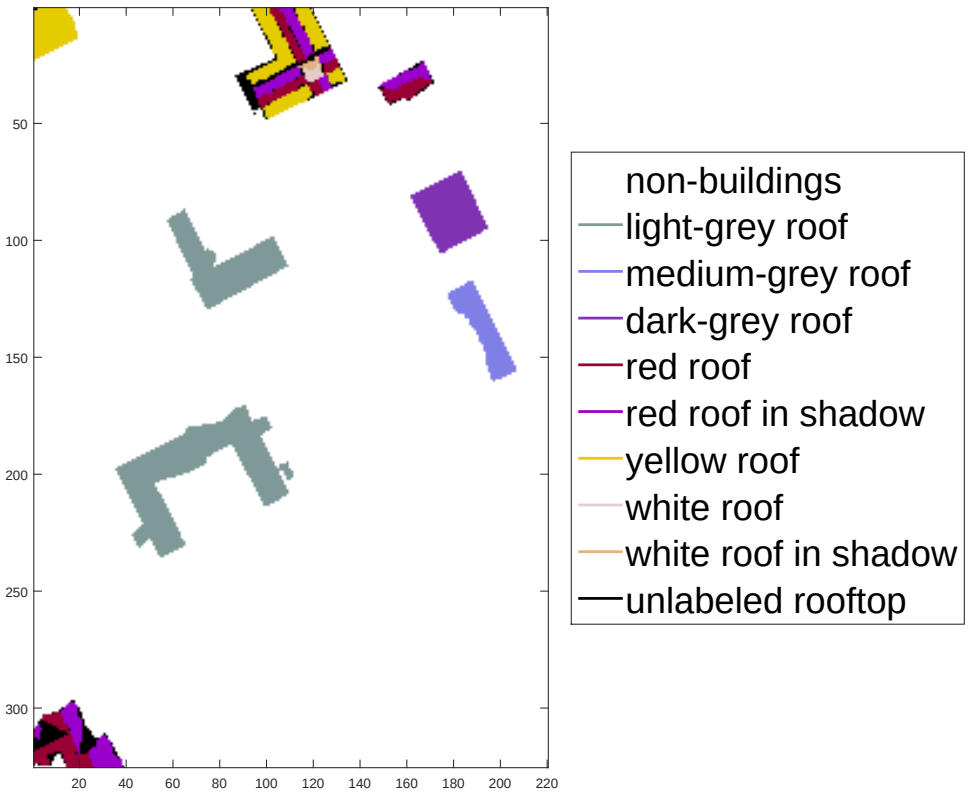

Figure 3: Sub-class label map for "buildings" class in MUUFL Gulfport campus 1 hyperspectral imagery.

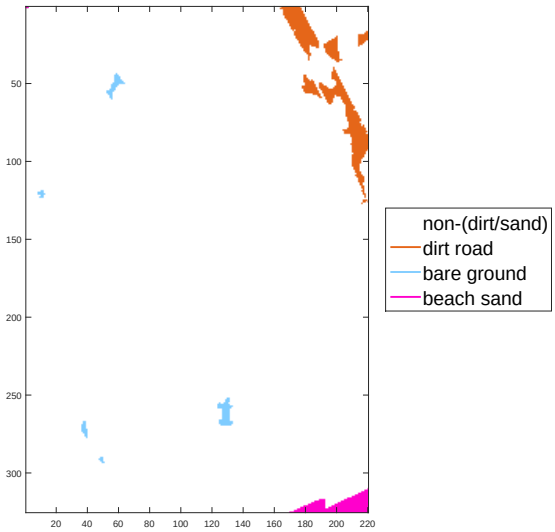

Figure 4: Sub-class label map for "dirt and sand" class in MUUFL Gulfport campus 1 hyperspectral imagery.

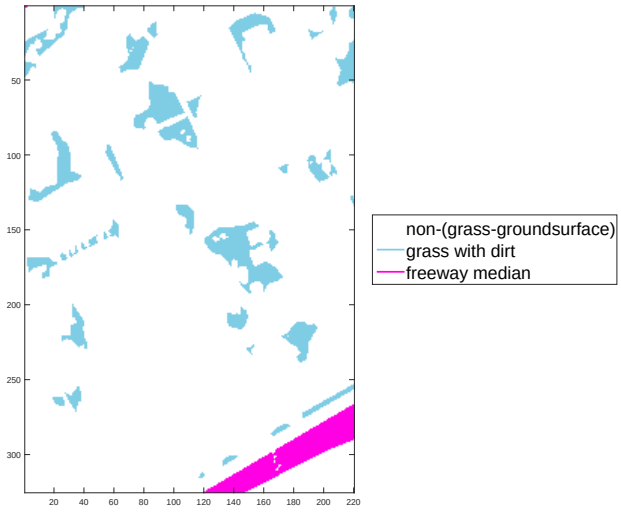

Figure 5: Sub-class label map for "mixed ground surface" class in MUUFL Gulfport campus 1 hyperspectral imagery.

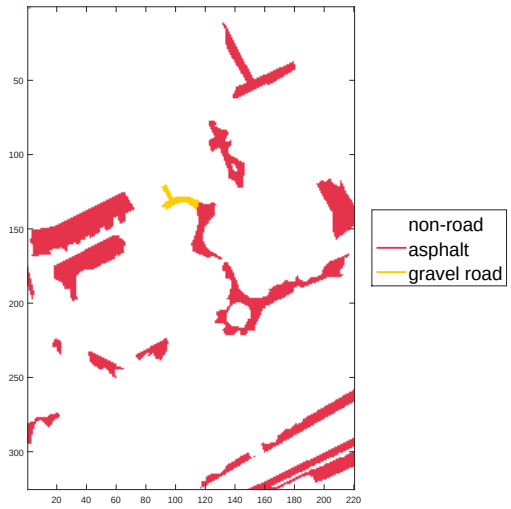

Figure 6: Sub-class label map for "road" class in MUUFL Gulfport campus 1 hyperspectral imagery.

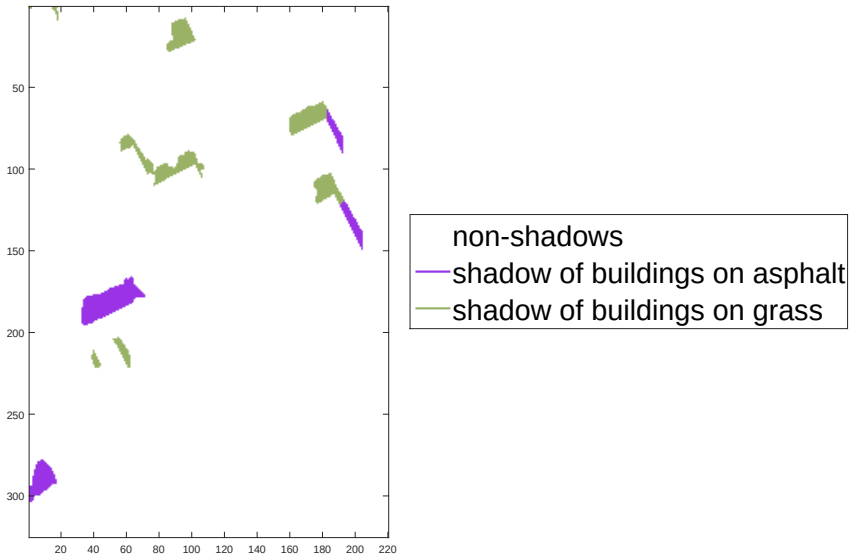

Figure 7: Sub-class label map for "shadow of buildings" class in MUUFL Gulfport campus 1 hyperspectral imagery.

Table 1: Descriptions on all the fields for the scene labeling groundtruth MATLAB structure.

Field Name	**Description**
info	Structure that contains information and description about hyperspectral data.
Data	$325 \times 220 \times 64$ matrix, the hyperspectral imagery data cube with 64 bands.
Northing	Northing range.
Easting	Easting range.
Lat	Latitude.
Lon	Longitude.
Lidar	Cell structure that contains the lidar data (co-registered) on two flights.
groundTruth	Structure that contains targets (cloth panel) ground truth locations and target types.
sceneLabels	Structure that contains the scene labeling ground truth maps, including high-level labels and sub-class labels.
RGB	the RGB image for the HSI data

the data set were labeled either into one of the eleven classes, or remained as "unlabeled points". As described in Sections 1 and 2, some material types are further labeled into sub-classes. For material types that do not have sub-class, the sub-class value is set to "1"; for material types that do have sub-class labels, all the pixels in that specific class are labeled further into labels $1, ...m, -1$ where m is the number of sub-classes labeled and -1 is the unlabeled sub-class points. Table 2 provides descriptions on the "hsi.sceneLabels" fields inside the structure.

Table 2: Descriptions on the "sceneLabels" fields for the scene labeling groundtruth MATLAB structure.

Field Name	**Description**
Materials_Type	The material types (classes for labeling), including trees, mostly-grass ground surface, mixed ground surface, dirt and sand, road, water, buildings, shadow of buildings, sidewalk, yellow curb, cloth panels (targets). All the pixels in the data set were labeled either into one of the eleven classes, or remained as "unlabeled points".
Materials_rowIndices	Row indices for all the pixels labeled in each material type.
Materials_colIndices	Column indices for all the pixels labeled in each material type.
Materials_Indices	Pixel indices (in the 325×220 image) for all the pixels labeled in each material type.
subLabels_description	This field provides name descriptions for sub-class labels for the following classes: buildings, mixed ground surface, dirt and sand, road, and shadows. These classes are visually identifiable to contain mixed materials and are therefore provided with more detailed sub-class labels. Materials from one sub-class usually have distinct spectral signature from another sub-class material. Each cell includes the names of such sub-class.
subLabels_labels	The field contains sub-class labels. For material types that do not have sub-class, the value is set to "1"; for material types that do have sub-class labels, all the pixels in that specific class are labeled further into labels $1, ...m, -1$ where m is the number of sub-classes labeled and -1 is the unlabeled sub-class points. Each sub-class label corresponds to "subLabels_description".
labels	The 325×220 image of the high-level labels for each of the following twelve class in the scene: trees (label "1"), mostly-grass ground surface (label "2"), mixed ground surface (label "3"), dirt and sand (label "4"), road (label "5"), water (label "6"), buildings (label "7"), shadow of buildings (label "8"), sidewalk (label "9"), yellow curb (label "10"), cloth panels (targets) (label "11"), and unlabeled points (label "-1").

References

[1] Paul Gader, Alina Zare, Ryan Close, Jen Aitken, and Grady Tuell. Muufl gulfport hyperspectral and lidar airborne data set. Technical Report Tech. Rep. REP-2013-570, University of Florida, Gainesville, FL, Oct. 2013.