



Hyperspectral and LiDAR Data Fusion for Species Classification(3D)

By

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*Indian Institute of Space Science and Technology
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Geosmart India 2016

2nd March 2016



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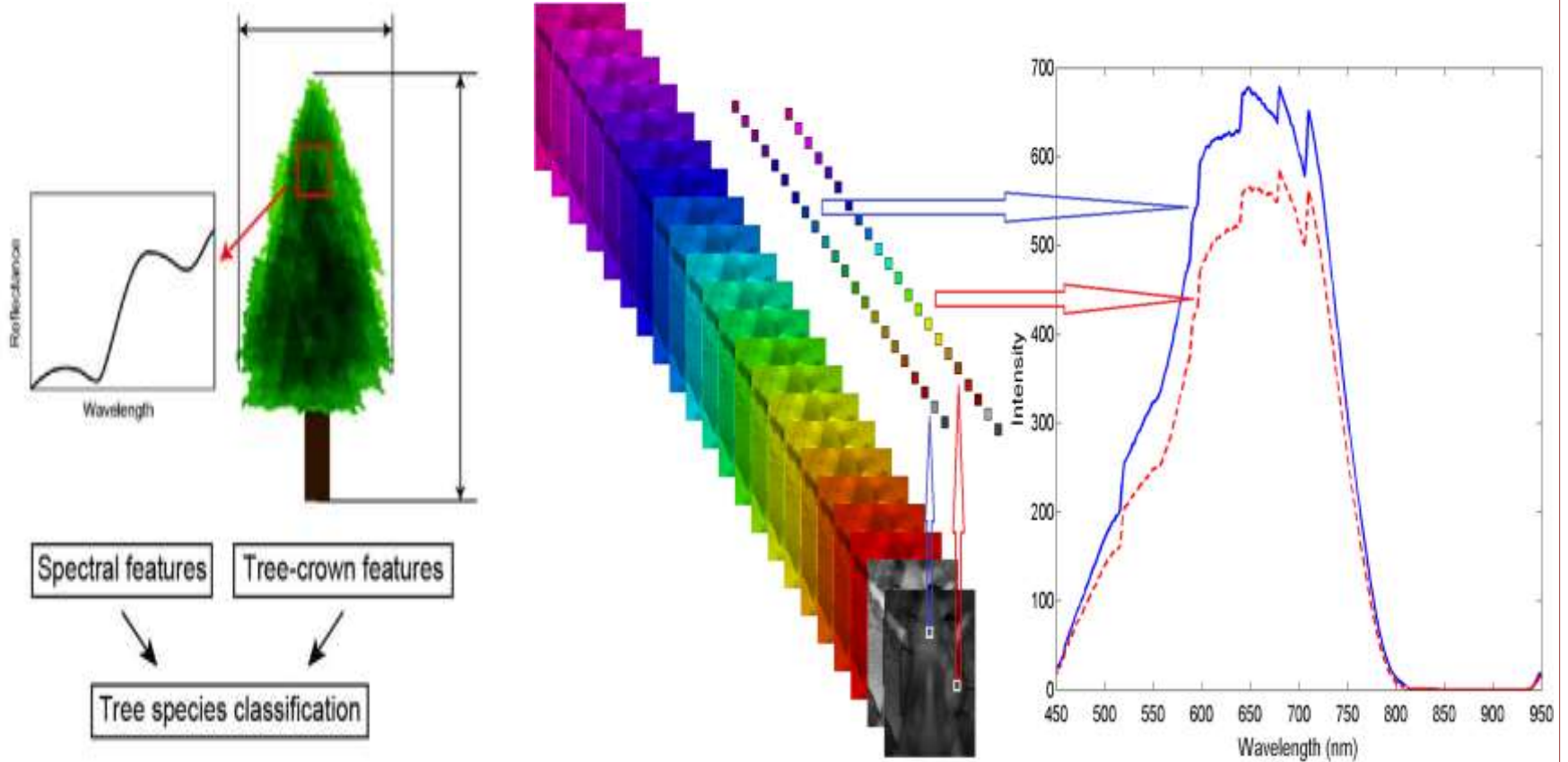
2nd March 2016

OUTLINE

- Introduction
- Motivation
- Objectives
- Data
- Work Flow
- Results



Concept of Fusion



MOTIVATION

- ❖ Most studies that were based on combining hyperspectral- and LiDAR-derived vegetation height data for tree species level application relied LiDAR derived data(DSM,DTM) and, thus, ignored many features that lie in LiDAR point cloud.
- ❖ Species level classification of LiDAR point cloud for further applications such as biomass calculation, 3D reconstruction etc.



OBJECTIVES

1. Species level classification on the given area using hyperspectral image data & Lidar point cloud - using Dimensionality Reduction Methods
2. “Hyperspectral” & “LiDAR point cloud” data Fusion and Classification



STUDY AREA



- San Joaquin Experimental Range, The National Ecological Observatory Network (NEON) Distributed Plot AOP116
- The plot center coordinates : 256838.6 E, 4110820.05 N, UTM Zone 11N (37.112159 Latitude, -119.736625 Longitude)
- total area → 250 * 250 sq.m
- The area is an open woodland dominated by blue oak, interior live oak, and gray pine with scattered shrubs and a nearly continuous cover of herbaceous plants.



DATA

LiDAR data:

- Number of points recorded : 567197
- Number of points by return : 487302 79857 18 18 0
- Point density : 9.075

Hyperspectral data:

- Dimension : 250 x 250 x 426
- Size : 53,250,000 bytes
- Projection : UTM zone 11 North
Pixel : 1 meter
- Datum : WGS 84
- Wavelength : 0.38227 to 2.51124 Micrometers



Hyperspectral Data

Pre Processing

Classification

Lidar Data

Pre Processing

Classification

Work Flow

Fusion

Classification

Results



Objective - 1

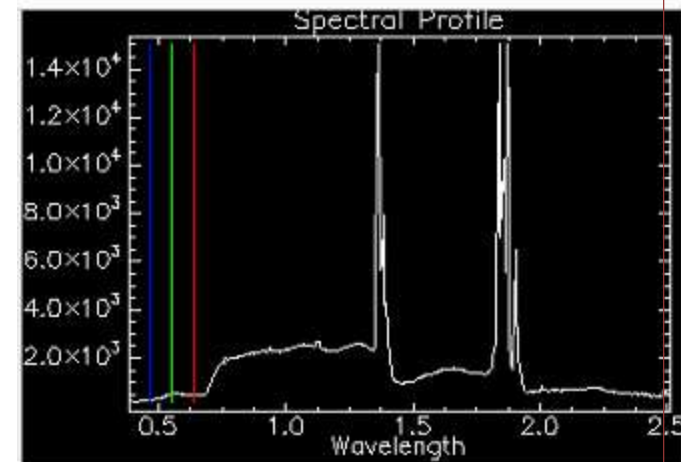
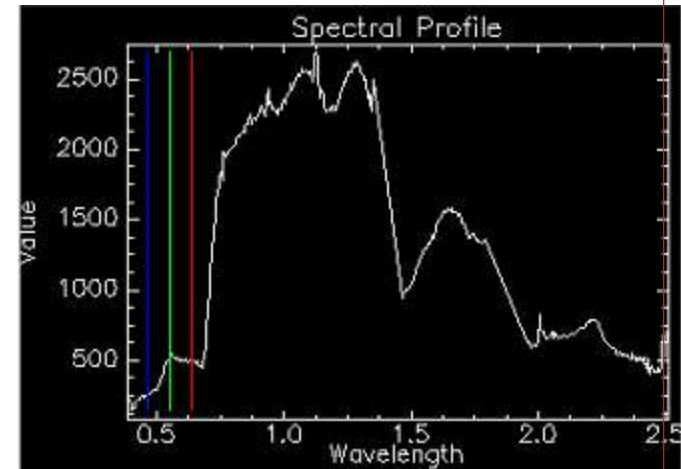
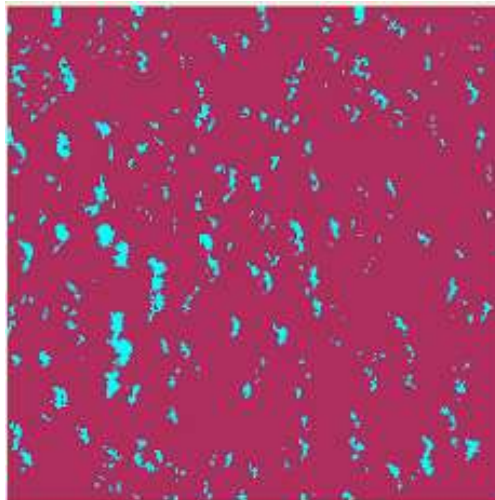
Classification

- Hyperspectral Data
 - Preprocessing
 - Water absorption bands removal
 - Shadow removal
 - Dimensionality reduction
 - PCA
 - Classification
 - RandomForest
- LiDAR Data
 - Classification
 - RandomForest



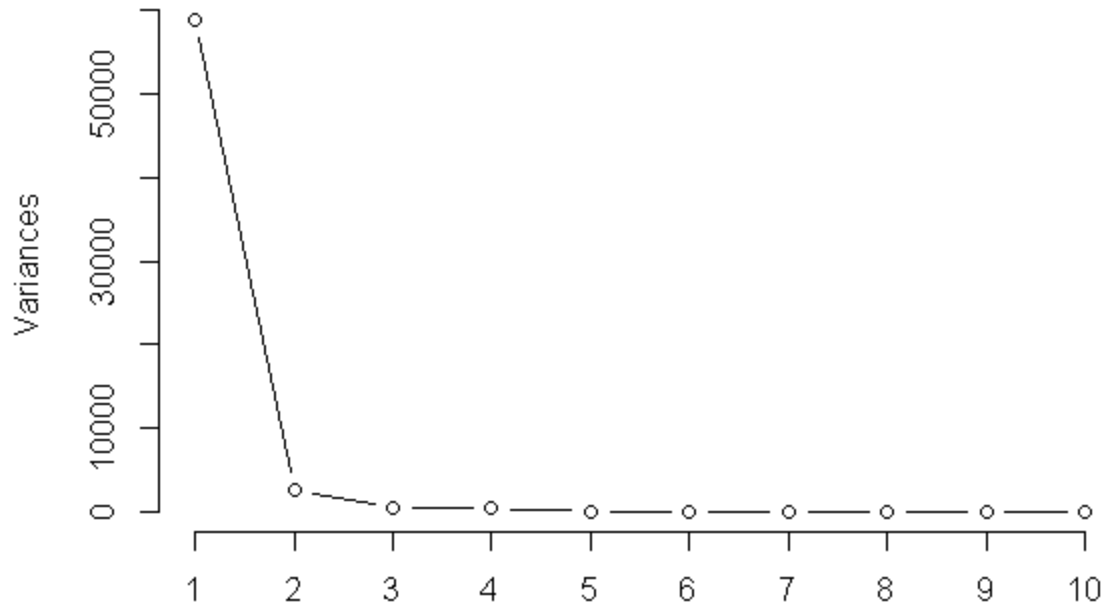
Hyperspectral Data Preprocessing

- 1. Water absorption bands removal(1350-1460 & 1790-1960)
 - Total band from 426 to 371
 - 55 bands removed (resampling : cubic convolution)
- 2. Shadow Removal
 - Shadow and Non Shadow samples are selected, and done classification using SVM
 - Out of 62500 pixels 3492 pixels removed



Hyperspectral Data - Dimensionality Reduction

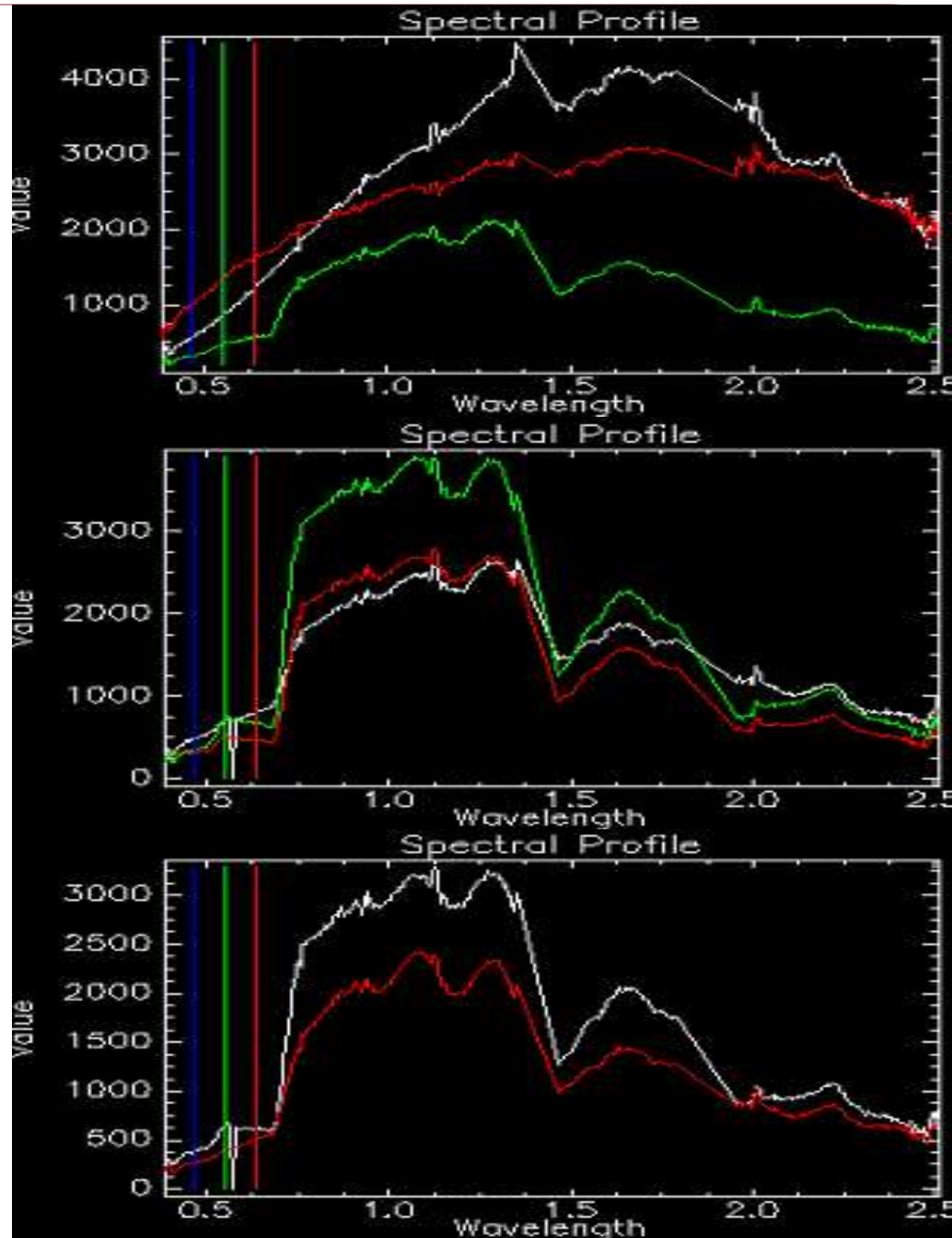
- PCA
 - Took 20 band ->99.69%

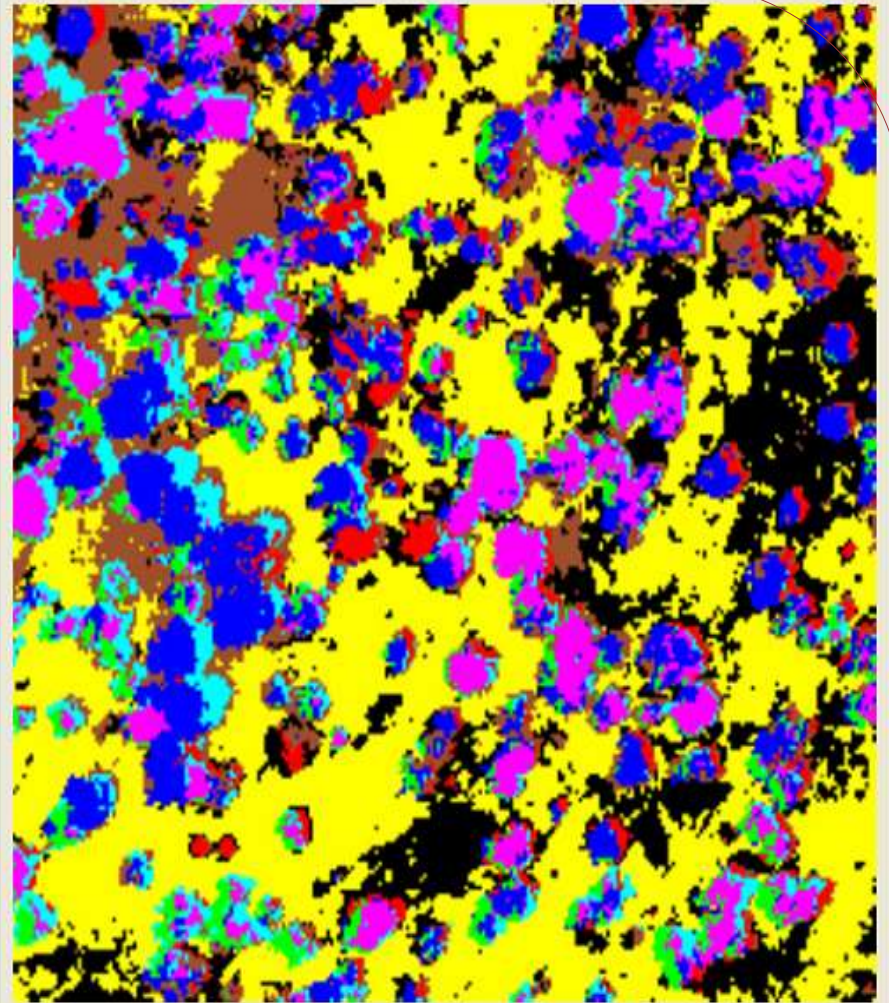


- White - soil
- Red - Rock
- Green - Grass

- White - Pine
- Red - Blue Oak
- Green - Live Oak

- White - Calflora
- Red - Unknown

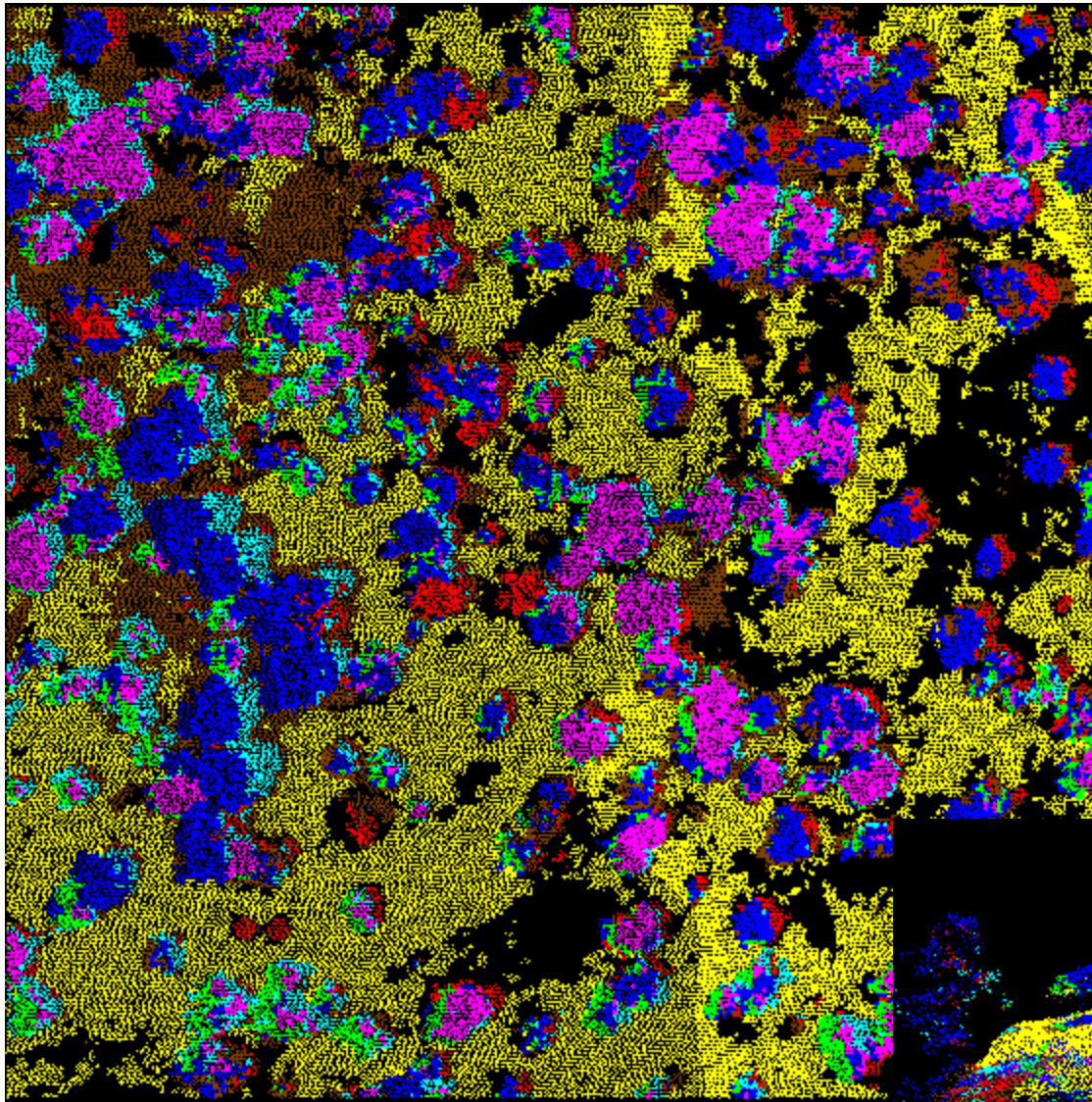




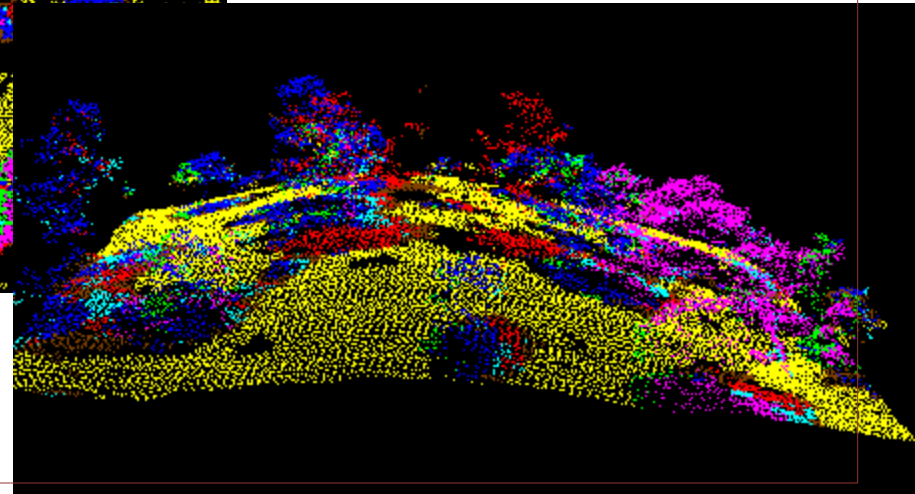
- Rock
- Soil
- Grass
- Pine

- Live Oak
- Blue Oak
- Calflora
- Unknown

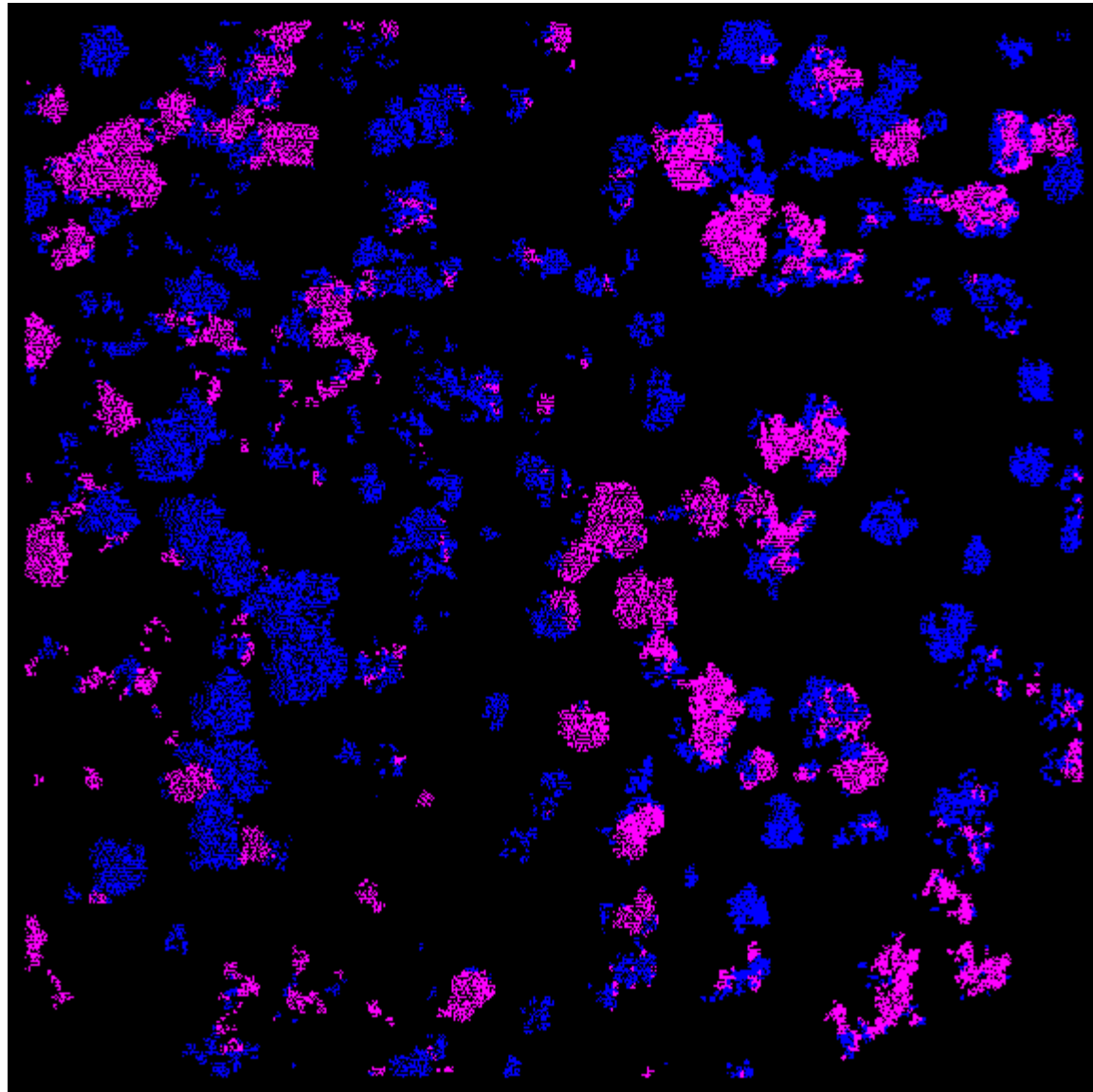




-  Rock
-  Soil
-  Grass
-  Pine
-  Live Oak
-  Blue Oak
-  Calflora
-  Unknown



Oak Classified

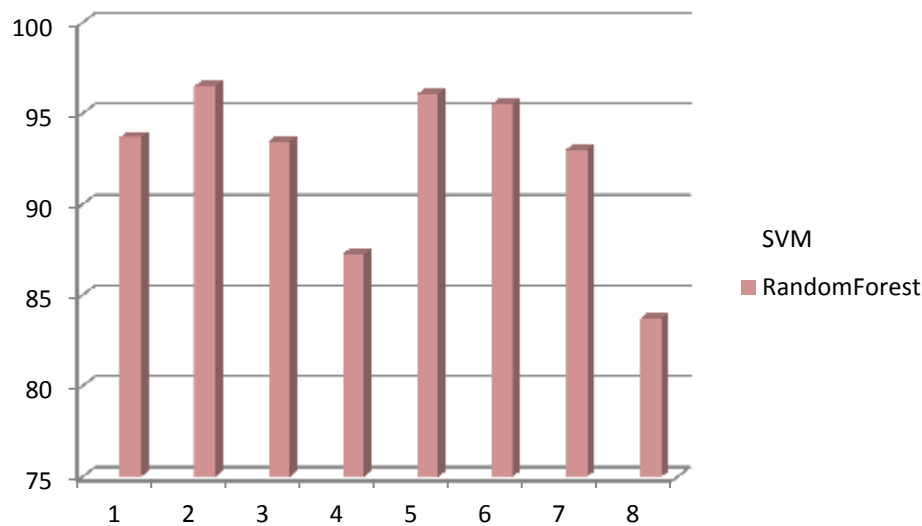


■ Live Oak
■ Blue Oak



Hyperspectral Data - Classification

- RandomForest : 91.74 %



- 1 - Rock
- 2 - Soil
- 3 - Grass
- 4 - Pine
- 5 - Live Oak
- 6 - Blue Oak
- 7 - Calflora
- 8 - Unknown

	true							
pred	1	2	3	4	5	6	7	8
1	3127	178	75	21	0	16	0	0
2	301	7083	107	4	0	8	3	3
3	88	38	2453	45	2	37	10	99
4	4	0	12	312	0	1	0	1
5	0	0	2	0	1595	83	38	34
6	0	4	72	48	65	2426	55	28
7	0	2	14	0	44	36	758	17
8	0	3	2	8	12	12	3	280

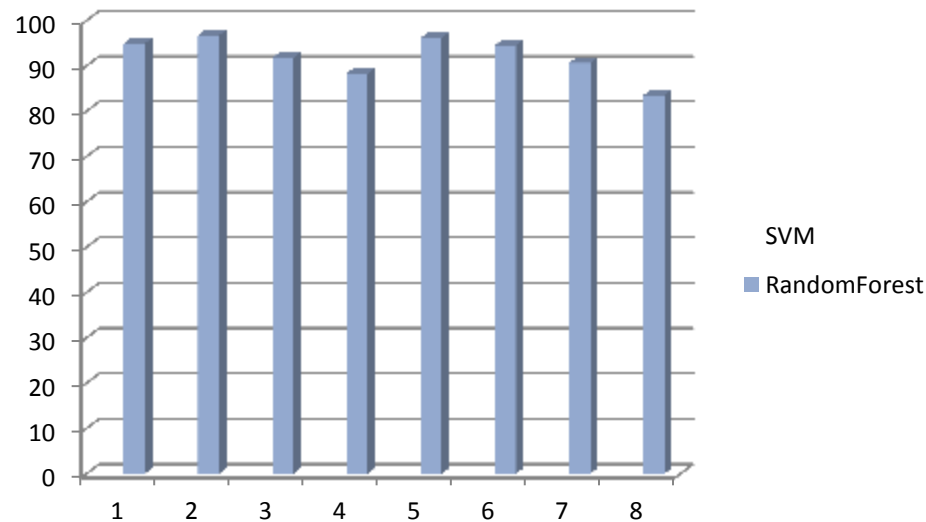


LiDAR Point Cloud - Classification

- RandomForest : 90.95%

pred \ true	1	2	3	4	5	6	7	8
1	28026	1288	545	182	6	273	33	10
2	1568	55629	894	42	10	120	210	141
3	592	627	19608	283	103	786	213	321
4	97	23	174	3320	14	137	15	18
5	4	19	153	30	18828	674	486	382
6	300	108	1145	389	636	26909	616	266
7	43	207	241	44	369	458	7991	215
8	6	53	199	26	185	96	153	2806

- 1 - Rock
- 2 - Soil
- 3 - Grass
- 4 - Pine
- 5 - Live Oak
- 6 - Blue Oak
- 7 - Calflora
- 8 - Unknown



Objective - 2

Data Fusion

Hyperspectral (20 PCs) + LiDAR

Bilinear Convolution : The returned values are interpolated from the values of the four nearest raster cells

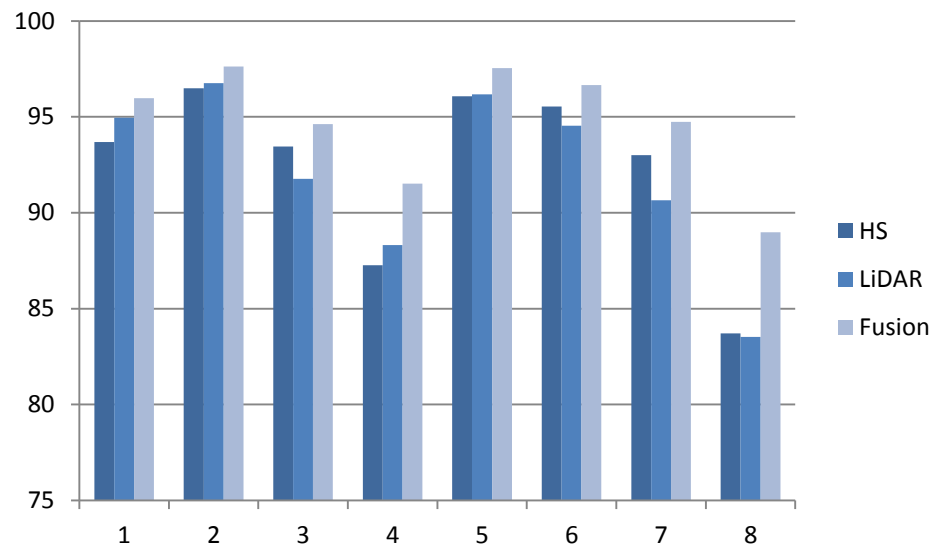


Fusion - Classification

- RandomForest : 93.87%

		true							
pred		1	2	3	4	5	6	7	8
1	28465	991	442	100	1	186	5	3	
2	1331	56294	573	14	1	61	97	73	
3	544	524	20959	290	43	506	109	293	
4	44	7	116	3462	3	69	9	15	
5	0	6	46	4	19533	380	271	254	
6	166	42	707	235	453	27726	396	177	
7	13	111	155	23	254	254	8663	142	
8	4	45	103	34	127	72	73	3246	

- 1 - Rock
- 2 - Soil
- 3 - Grass
- 4 - Pine
- 5 - Live Oak
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- 7 - Calflora
- 8 - Unknown



Results

	RF
HS	91.74 %
LiDAR	90.95 %
FUSION	93.87 %

- LiDAR and hyperspectral image fusion improved the classification accuracy for species discrimination
- Can be used for further application



