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Using Remote Sensing Infrared Imaging to Study Airport Runway Surface Types

Kenneth W. Rush, University of Texas at Tyler,
krush@patriots.uttyler.edu
Chesapeake Information Based Aeronautics Consortium,
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Research advisor: Dr.Fred Wilson

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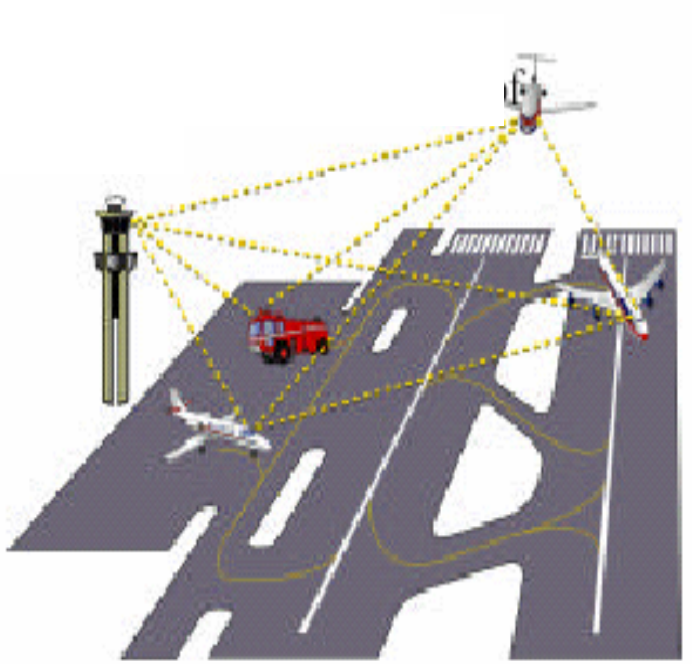
INTRODUCTION

- Study Runway surface Types using Remote Sensing (RS) Technology.
- Support NASA Research by implementing technologies that help prevent runway incursions in support of CIBAC and Safe-Flight 21 program
- Use ENVI remote sensing software and high resolution IKONOS satellite images.

Safe-Flight 21

- Safe-Flight 21 is a collaboration of the FAA, NASA and various other agencies that are working to gain a better understanding of the causes of runway incursions.
- Better runway layouts, improved signage and lighting, technologies to prevent runway mishaps etc…



Background

- In 2000, FAA Office of Runway Safety, sponsors programs to reduce runway accidents .
- The Safe-Flight 21 Program awarded contracts for development of avionics and implementation of technologies that are designed to prevent incursions.
- Incursions often occur during periods of low visibility. Airborne dust, clouds, and nightfall hamper runway visibility.
- Pilots are less able to see the runway surfaces due to dependency on visible light band.
- Use of Infrared (IR) band could help distinguish runway surfaces better regardless of prevailing atmospheric conditions.
- Level of flight safety would be improved having access to such runway data in any condition.

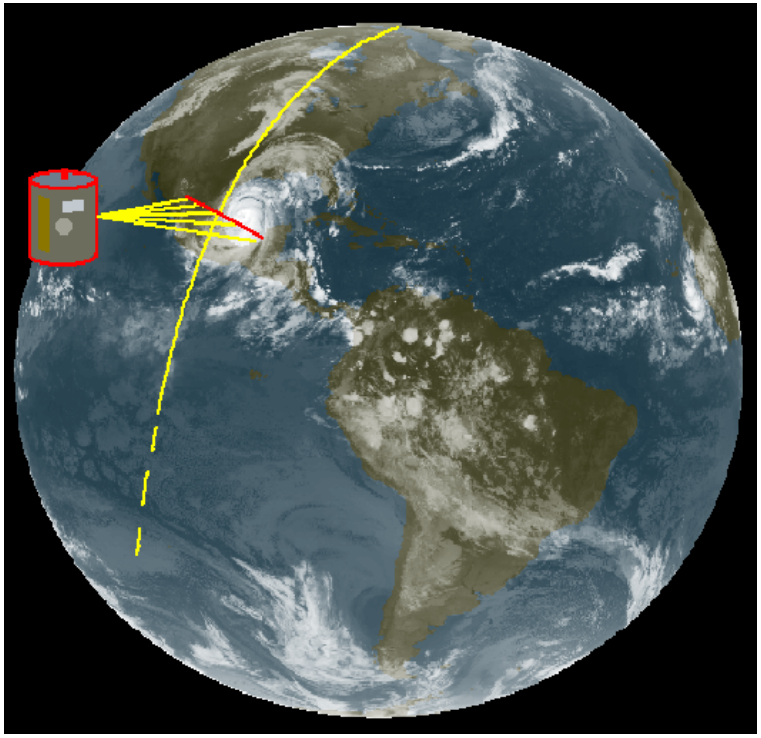
Objective

- Use ENVI software to extract runway attributes from IKONOS satellite images.

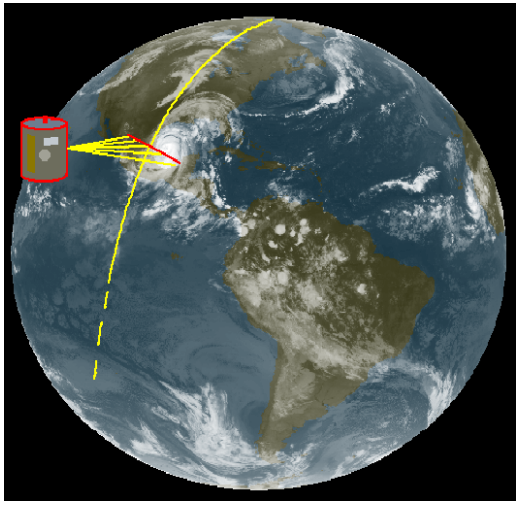
- This attribute data could be used as a surface layer input for a map-moving digital terrain sent to a cockpit display.

What is remote sensing?

- Collecting data from object without actually touching it.
- Uninterrupted operation.
- Cost effective.



Satellite Operating Modes

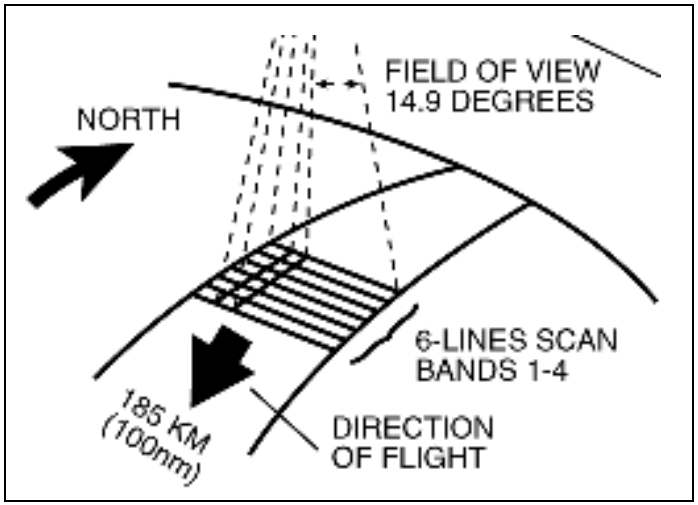


MULTISPECTRAL

- Spectral: 4 bands
- Spatial: 4m
- Temporal: 3 days

PANCHROMATIC

- Spectral:1 Band (B/W)
- Spatial: 1m
- Temporal: 3 days



Infrared Energy

- Band of energy in the Electromagnetic Spectrum.

Bandwidth

- 0.76 – 0.90 um

Methodology

- Establish study areas (MSU/BWI).
- Ground-truthing, site identification, field analysis log.
- Display IKONOS image of MSU in four bands Blue, Green, Red, Near Infrared.
- Extract pixel digital number values (Attribute Data).
- Perform statistical analysis of DN values.
- Repeat method for BWI.

Extracting attribute data

Results:

Table 1. Extracted attributes of Bright runway surfaces in BWI image. KEY: B-Band.

#	Site No.	Coordinates		Band DN (val)				Comment
1	2	3	4	5	6	7	8	9
		Lat	Long	Band1	Band2	Band3	Band4	
1	1	39 10 53.73 N	76 40 24.74 W	255	255	255	218	rough surface
2	2	39 10 51.69 N	76 40 22.19 W	255	255	255	255	bright surface
3	3	39 10 45.29 N	76 40 16.20 W	133	117	101	52	bright surface
4	4	39 10 42.72 N	76 40 14.31 W	255	255	255	255	bright surface
5	5	39 10 36.34 N	76 40 6.32 W	252	248	244	201	smooth surface
6	6	39 10 33.45 N	76 40 9.25 W	231	232	226	166	smooth surface
7	7	39 10 37.27 N	76 40 14.51 W	213	212	214	154	rough surface
8	8	39 10 41.36 N	76 40 18.61 W	112	141	161	126	rough surface
9	9	39 10 44.95 N	76 40 21.69 W	157	198	223	196	
10	10	39 10 52.13 N	76 40 27.70 W	255	255	255	223	
11	11	39 10 41.42 N	76 40 4.94 W	119	179	189	149	smooth surface
12	12	39 10 37.91 N	76 39 56.36 W	196	203	198	141	
13	13	39 10 42.66 N	76 40 0.47 W	185	102	94	39	
14	14	39 10 45.69 N	76 39 57.04 W	199	200	200	159	
15	15	39 10 41.34 N	76 39 52.44	168	169	166	116	
16	16	39 10 47.95 N	76 39 53.42 W	150	155	152	104	
17	17	39 10 53.36 N	76 39 46.88 W	217	191	172	119	
18	18	39 10 50.09 N	76 39 57.64 W	164	153	152	101	
19	19	39 10 54.95 N	76 40 2.76 W	220	229	228	181	
20	20	39 11 13.52 N	76 40 1.36 W	143	153	161	106	slightly dark
Total				3879	3902	3901	3061	
Average				193.95	195.1	195.05	153.05	
Std. Dev.				48.58251	48.03825	49.46181	60.263	
KEY								
B - Band								

Results

Table 2. Partial list of Digital Number values from MSU. KEY: B-Band.

		Asphalt				Concrete			
	Site No.	B1	B2	B3	B4	B1	B2	B3	B4
	1	55	255	245	146	255	255	255	255
	2	190	183	174	140	255	255	255	240
	3	244	245	238	148	255	255	255	231
	4	251	248	237	147	228	223	212	141
	5	245	255	241	159	232	232	220	193
Sum		1185	1186	1135	740	1225	1220	1197	1060
Average		237	237.2	227	148	245	244	239.4	212
Std.Dev.		**26.655**	**30.6137**	**29.791**	**6.89202**	**13.766**	**15.3948**	**21.548**	**45.8148**

Results

- Table 2. Standard deviations for concrete and asphalt surfaces for MSU AND BWI.

	Standard Deviations			
	BWI runways		MSU grounds	
	Dark	Light	Asphalt	Concrete
B1	66.95	48.58	45.00	51.35
B2	69.98	48.03	43.99	41.79
B3	68.97	49.46	38.50	44.97
B4	76.11	60.26	27.00	41.27

Conclusion

- For each site number, the digital values in the bands were different. Thus, more bands yield more information.
- Evaluation of standard deviations will determine if the data from MSU can qualify to assist with classifying the runway surfaces as either concrete or asphalt.

Future Research

- I'd like to see knowledge discovery through spectral imaging applied to nanobots in biomedical applications.

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