GEOLOGICAL SURVEY CIRCULAR 616

Sensor Detection Capabilities Study

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By John E. Wilson

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CONTENTS

ILLUSTRATIONS

TABLES

Sensor Detection Capabilities Study

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INTRODUCTION AND RATIONALE

The present state of remote sensing technology is the result of a large number of investigations concerning the use of both imaging and nonimaging sensor devices to detect and analyze various phenomena. This report summarizes results of a study in which 10 of those sensors were investigated and rated on their effectiveness in identifying characteristics of 98 earth resources targets.

Other investigations have not previously been correlated in a single document to summarize the relative capabilities of each sensor, applied to specific ground targets. In this study, the capabilities of each sensor have been listed and rated, in decreasing order of effectiveness from 1 to 8, through comparative analysis of sensor records. A project may require the use of one or more remote sensing devices, and the earth scientist is then confronted with the problem of instrument selection. Four major variables which affect the selection of an appropriate sensor are:

1. Target and background identity.
2. Sensor availablility.
3. Sensor capabilities and characteristics.
4. Data collection system economics.

Other variables are:

1. Time of day.
2. Longitude.
3. Cloud cover.
4. Precipitation.
5. Dust, smoke, fog.
6. "Look" angle.
7. Sun angle.
8. Weather history.

Consequently, the earth scientist with only a basic knowledge of remote sensing is confused by the detail required to make a confident selection of a system for a given research program.

METHODOLOGY

A list of earth science targets was first proposed, sufficient in number to allow for study depth and diversity, while maintaining a manageable number of indicator objects to satisfy the different users of those sensing devices. That list was submitted to Geological Survey personnel for study, additions, and deletions, and the modified list was accepted for project use. A mission was then evolved with multiple flightlines to provide sensor records for a majority of the listed objects. The flight mission (NASA Mission 73) utilized sensing devices that spanned a significant part of the electromagnetic spectrum from ultraviolet through airborne radar, and sensor redundance was provided whenever possible.

From the resultant images and signals, data sets were compiled. These sets, one for each target, normally consisted of one or more presentations of that target with representative data from each sensor. In addition to analyzing these data, a library search was made, and several Government agencies were visited, to view other pertinent multisensor images. Sensor records that were viewed and rated included:

1. Black and white photography.
2. Color photography.
3. Infrared (IR) color photography.
4. Black and white infrared photography.
5. 2- to 4-micron thermal infrared imagery.
6. 8- to 14-micron thermal infrared imagery.
7. Side-looking radar (SLAR) imagery.
8. Electro-optical (television) imagery.
9. Imaging microwave imagery.
10. Nonimaging scatterometer data.

Black and white photography as rated here includes multiband photography. Such photographic and electro-optical devices are evaluated as if the optimum filter for a given task was used.

The selection of the most appropriate airborne or spaceborne device for a given survey has become progressively more difficult with the development and (or) improvement of sensor systems. In past years, this selection was restricted to an airborne camera and panchromatic film. Present technology poses a choice among many instruments. Some of the newer sensors do not form an image but return an electric signal which varies in amplitude as changes in the target are encountered. All of the electromagnetic sensors record object reflectance, absorption, or radiation in wavelengths from 400 millimicrons to nearly 1.5 centimeters. Representative imagery produced by these sensors is shown in figures 1 through 7.

The quality determinations set forth in this report are subjective and are based on images derived from aircraft mounted sensors. Where a sensor is not rated, no capability is presumed to exist. The ranking of sensors by a succession of numbers does not imply that the higher rated sensors will accomplish any given detection task with precision and quality. The ratings are strictly relative; the detection capabilities of one sensor system are compared with another for each individual target.

No consideration is given here to those variables which affect sensor performance. Instead, performance ratings are based on the supposed optimum conditions existing at the time each target is sensed. Camouflage caused by rain, fog, and clouds can change detection probabilities, and the probability and direction of such changes should be considered in sensor selection.

The attached evaluation sheets are arranged in alphabetical order of the selected targets. The numbers represent the order of capability for the rated sensor to function successfully in detecting and identifying the target object under study. Where no capability order is shown, no detection-recognition capability exists at present.

Because this report concludes that photographs of one type or another offer the greater remote sensing capability in most instances, it would appear appropriate to define the camera systems utilized. Performance evaluations are for low altitude (daylight), high altitude (daylight), and low altitude (night) conditions. Low altitude is presumed to include altitudes between 1,000 and 5,000 feet, while high altitude is based on a presumed altitude anywhere between 10 miles and 100 miles. Night data are given only for a presumed low altitude platform since no currently available infrared set or radar systems would yield useful data from orbital or extreme flight altitudes on targets under consideration in this report.

All low altitude evaluations are based on high quality, commercially available framing cameras, while the high altitude (or satellite) platform envisions the use of a hypothetical system capable of a 10-foot ground resolution. The practicality of such ground resolution has been extrapolated from performances achieved by use of commercially available components at far lower altitudes.

INTERNAL ACCURACY DETERMINATION

Performance data for all of the sensor-target combinations were assembled in a matrix. The matrix was then reviewed for internal contradictions. When such contradictions were found, target and sensor relationships and characteristics were reviewed; new performance judgments were derived when indicated; and the new data were examined in the framework of the accuracy matrix.

SUMMARY OF RESULTS

Of the 98 targets considered in this evaluation, 89 indicated that a photographic system held the greatest promise of object detection. Infrared, side-looking radar, scatterometer, and passive microwave each were capable of significant contributions over one or more of the listed targets.

Sensor evaluation indicated little spaceborne capability for extant devices other than photography. This is not to be construed as a condemnation of such sensors; rather, it reflects the need for continuing sensor improvement and continued investigation into the uses of "as is" imagery.

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FIGURES 1–7

Figure 1.—A conventional black and white aerial photograph. Such photography can have high geometric fidelity.

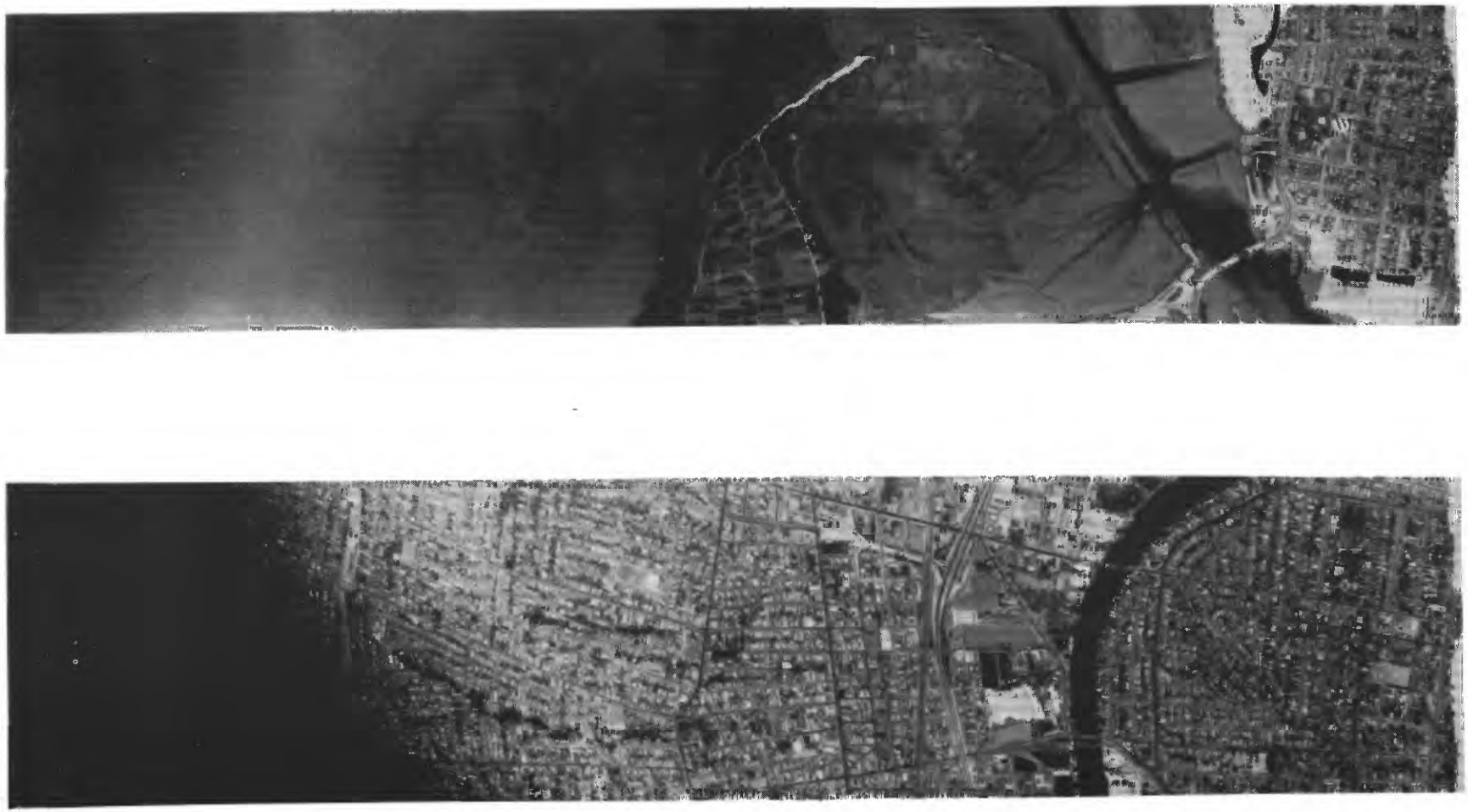

Figure 2.—Panoramic Photography. These two photographic strips butt together to form a single 120° photograph. Such photography is geometrically poor but is very perceptive of small ground details.

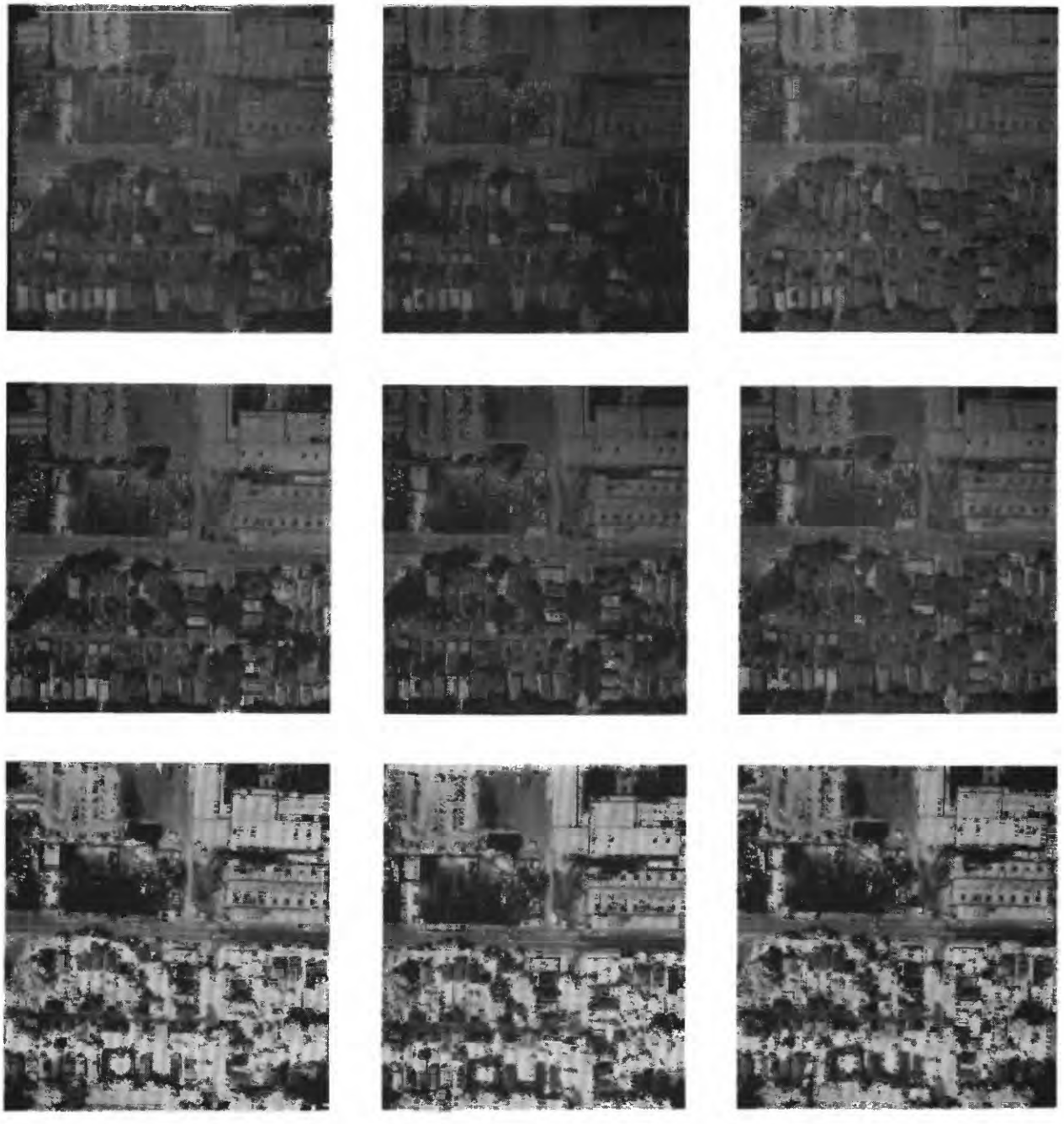

Figure 3.—A typical nine lens multiband camera exposure. Object density differences in the nine selectively filtered photographs can aid in object recognition.

Figure 4.—A negative image from a scanning infrared system flown during darkness. A cold river in the foreground and cold swamplands at the top are both displayed here as white.

Figure 5.—This low-altitude radar image of Portland, Oreg., displays the system's inability to provide information on any but very large objects.

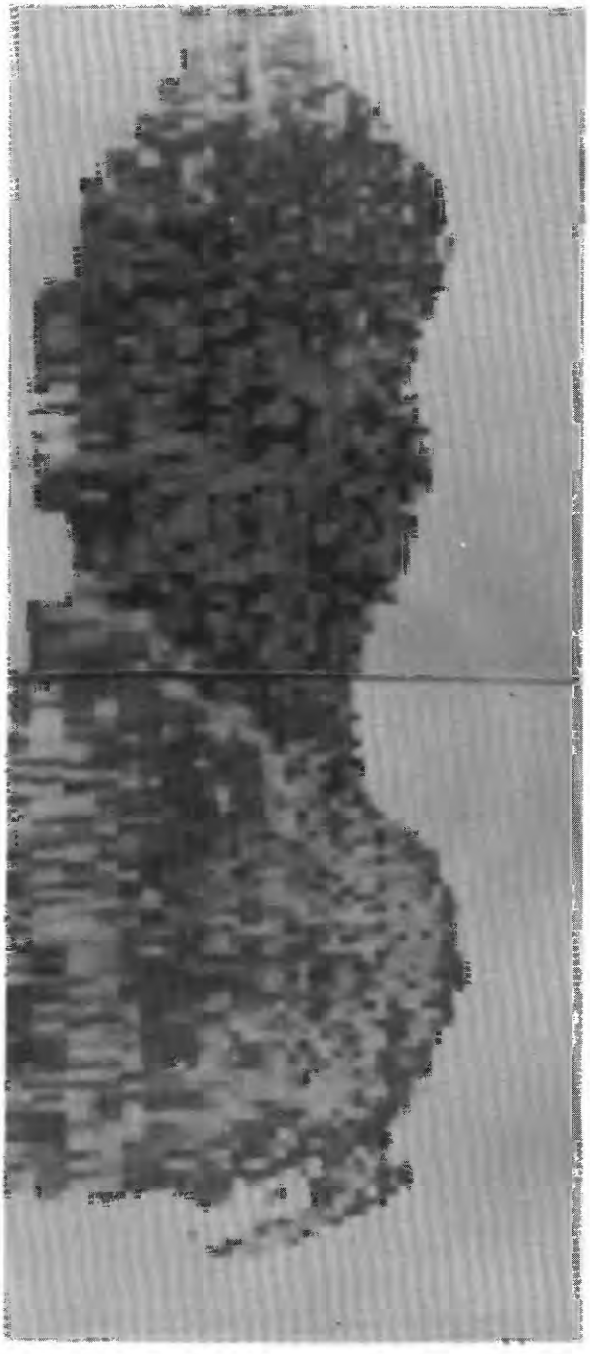

Figure 6.—Imaging passive microwave displays various surface temperatures of the Salton Sea as changing levels of gray.

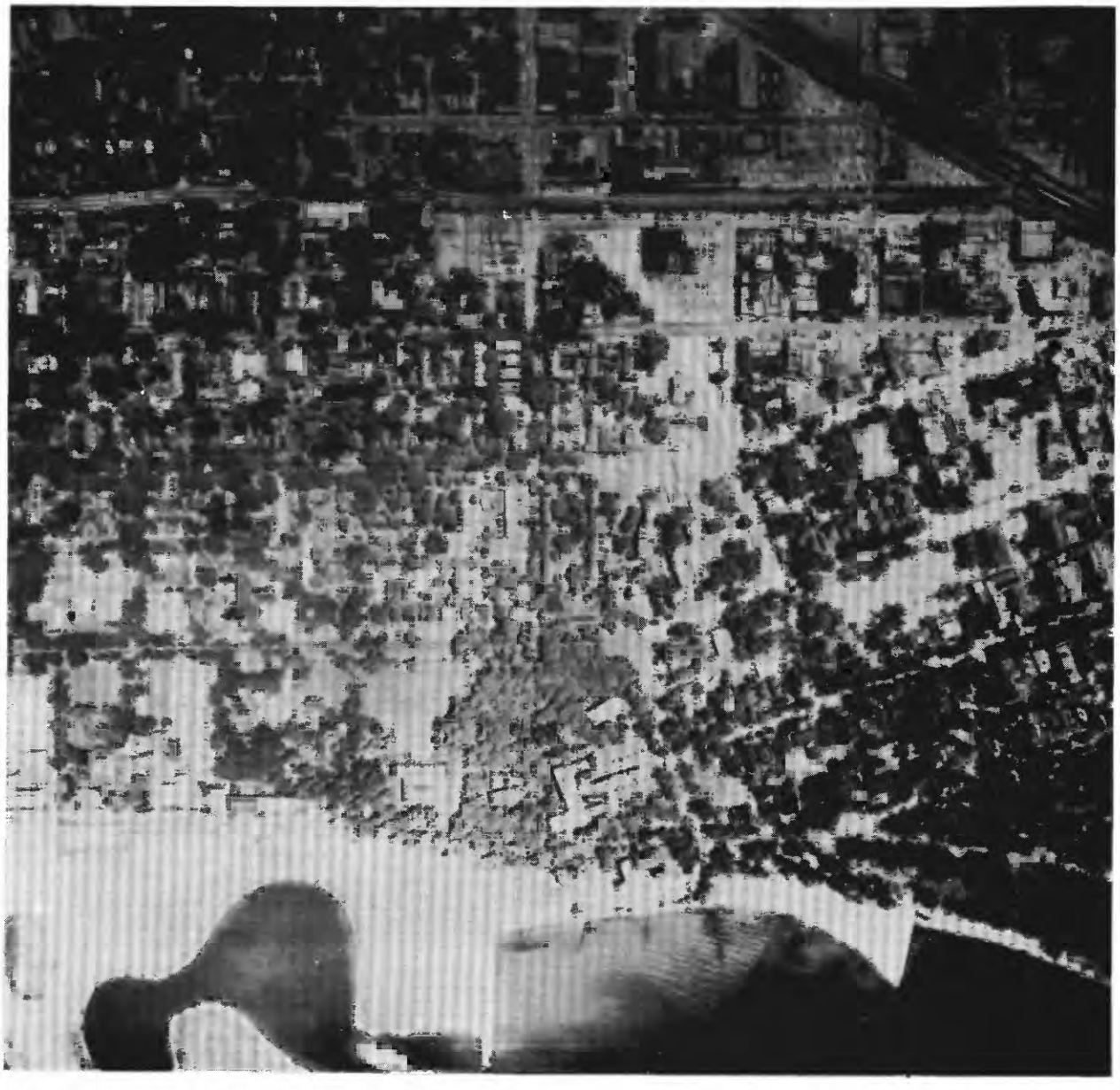

Figure 7.—This image was produced by a line scanning electro-optical system. The resultant quality is very close to that of a conventional camera system.

TABLES

[Ground resolution requirements are given in and night) are between 1,000 and 5,000 feet; miles. The numerical ranking of sensors is in highest rank (1) does not imply precision and

Sensor	Target identification requirements											
	Airfields											
	Location (100 ft)			Runway analysis (25 ft)[1]			Support facilities (10 ft or better)[2]					
	Daylight		Night	Daylight		Night	Daylight		Night			
	Low	High		Low	High		Low	High				
Black and white photography	1	1		1	1		1	1				
Color photography	2	4		2	4		2	4				
Infrared (IR) color photography	3	2		3	2		3	2				
Black and white infrared photography	4	3		4	3		4	3				
2- to 4-micron thermal infrared photography	6		1	6		1	7		2			
8- to 14-micron thermal infrared photography	7		2	7		2	6		1			
Side-looking radar (SLAR) imagery	8		3	8		3						
Electro-optical (television) imagery												
Imaging microwave imagery	5	5		5	5		5	5				
Nonimaging scatterometer												

[1]Length, bearing, and taxiway pattern.

[2]Hangars, POL storage, parking aprons, and control facilities.

Sensor	Target identification requirements—Continued											
	Canals (absorption and shape)			Cemeteries (total area, vegetation, and road network)			Crops					
							Bush (5 by 5 ft, regularity)					
	Daylight		Night	Daylight		Night	Daylight		Night			
	Low	High		Low	High		Low	High				
Black and white photography	2	1		3	1		2	1				
Color photography	4	4		2	4		4	4				
Infrared (IR) color photography	1	2		1	2		1	2				
Black and white infrared photography	3	3		4	3		3	3				
2- to 4-micron thermal infrared photography	7		2	6		1	7		2			
8- to 14-micron thermal infrared photography	6		1	7		2	6		1			
Side-looking radar (SLAR) imagery	8		3									
Electro-optical (television) imagery												
Imaging microwave imagery	5	5		5	5		5	5				
Nonimaging scatterometer												

parentheses. Low altitude evaluations (daylight high altitude (daylight only), between 10 and 100 decreasing order of effectiveness, but even the optimum quality]

Target identification requirements—Continued

Archeology site location (various, moderate differentiation)			Bridges									
			Construction detail (1 ft)			Deck material (tone and texture)			Length and width (10 ft or better)			Location within transportation network (50 ft)		
Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night
Low	High		Low	High		Low	High		Low	High		Low	High	
3	1		1	1		1	1		1	1		1	1	
2			2			2	4		2	4		2	4	
1	2		3	2		4	2		3	2		3	2	
4	3		4	3		3	3		4	3		4	3	
						7		2	6		1	7		2
						6		1	7		2	6		1
												8		3
5	4		5	4		5	5		5	5		5	5	

Target identification requirements—Continued

Crops—Continued										Dams (water body, water and (or) power distribution system)		
Cereal (texture, tone, and engineered field shape)			Forage (texture, tone, time of year, and IR reflectance)			Orchard (20 ft, regular spacing)			Vine (4- by 100-ft lines)			
Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night
Low	High		Low	High		Low	High		Low	High		Low	High	
3	1		2	1		3	1		4	1		2	1	
2	5		4	5		4	4		1	5		4	4	
1	2		1	3		1	2		2	2		1	2	
4	3		3	4		2	3		3	3		3	3	
7		2	6		1	6		1				7		2
6		1	7		2	7		2				6		1
5	4		5	2		5	5		5	4		5	5	

Sensor	Target identification requirements—Continued								
	Dams or ponds, 1 acre minimum (100 ft, stream pattern)			Drainage systems (linear patterns)			Earthquake areas (faults, slumps, shears, and shorelines)		
	Daylight		Night	Daylight		Night	Daylight		Night
	Low	High		Low	High		Low	High	
Black and white photography	3	1		3	1		1	1	
Color photography	4	4		4	4		4	4	
Infrared (IR) color photography	1	2		1	2		2	2	
Black and white infrared photography	2	3		2	3		3	3	
2- to 4-micron thermal infrared photography	7		2	7		2	6		1
8- to 14-micron thermal infrared photography	6		1	6		1	7		2
Side-looking radar (SLAR) imagery				8					
Electro-optical (television) imagery									
Imaging microwave imagery	5	5		5	5		5	5	
Nonimaging scatterometer									

Sensor	Target identification requirements—Continued								
	Flood areas (limits)			Flood plains, definition (shorelines, refuse lines, relief)			Forests		
							Forest areas (texture, tone)		
	Daylight		Night	Daylight		Night	Daylight		Night
	Low	High		Low	High		Low	High	
Black and white photography	3	1		2	2		4	1	
Color photography	4	4		3	4		3	4	
Infrared (IR) color photography	1	2		4	3		1	2	
Black and white infrared photography	2	3		1	1		2	3	
2- to 4-micron thermal infrared photography	7		2	7		2	6		1
8- to 14-micron thermal infrared photography	6		1	6		1	7		2
Side-looking radar (SLAR) imagery	10			8		3	8		3
Electro-optical (television) imagery	8	6	3				10		5
Imaging microwave imagery	5	5		5	5		5	5	
Nonimaging scatterometer	9						9		4

Target identification requirements—Continued

Estuarine studies (tone, absorption, solar flares, and shorelines)			Fill (tone, shadow, and temperature differences)			Fire (gross thermal differences)			Firelanes (linear clearings and fire trails)			Fish schools (surface turbulence, fish oils)		
Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night
Low	High		Low	High		Low	High		Low	High		Low	High	
1	1		1	1		6	4		3	1		1	1	
2	4		2			4	1		1	3		2		
3	3		3	3		5	2		2	2		4		
4	5		4	2		3	3		4	4		3		
7		2	6		1	2		2	7		2			
6		1	7		2	1		1	6		1			
8		3												
						7	5	3						
5	2		5	4					5	5		5	2	

Target identification requirements—Continued

Forests—Continued									Gross geologic structure			Ice		
Conifer[3]			Deciduous[3]			Mixed species[3]						Ice pack conditions		
Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night
Low	High		Low	High		Low	High		Low	High		Low	High	
4	1		4	1		4	1		2	1		3	1	
3	4		3	4		3	4		3	5				
1	2		1	2		1	2		5	3				
2	3		2	3		2	3		4	2				
6		1	6		1	6		1	7		2			
7		2	7		2	7		2	8		3			
									1		1	1		
												4		1
5	5		5	5		5	5		6	4				
8		3	8		3	8		3				2		2

[3]Texture, tone, photographic IR reflectance, and season of the year.

Sensor	Target identification requirements—Continued								
	Ice—Continued			Irrigation networks (dams, canals, and agriculture in an arid climate)			High-voltage lines (poles, footers, clearing activity, and insulators)		
	Ice pack distribution								
	Daylight		Night	Daylight		Night	Daylight		Night
	Low	High		Low	High		Low	High	
Black and white photography	2	1		3	3		1	1	
Color photography	1	4		4	4		2	5	
Infrared (IR) color photography	3	3		1	1		3	2	
Black and white infrared photography	4	2		2	2		4	3	
2- to 4-micron thermal infrared photography	7	7	2	7		2	7		2
8- to -4-micron thermal infrared photography	6	6	1	6		1	8		3
Side-looking radar (SLAR) imagery	8	8	3				6		1
Electro-optical (television) imagery	9	9	4				3		
Imaging microwave imagery	5	5		5	5		5	4	
Nonimaging scatterometer									

Sensor	Target identification requirements—Continued								
	Land use—Continued						Low-voltage lines (poles, lines, clearing)		
	Recreation (total area, road network, game fields, camp areas, water)			Residential (20- by 20-ft buildings, road network)					
	Daylight		Night	Daylight		Night	Daylight		Night
	Low	High		Low	High		Low	High	
Black and white photography	2	1		1	1		1	1	
Color photography	1	4		2	4		2		
Infrared (IR) color photography	3	2		3	2		4		
Black and white infrared photography	4	3		4	3		3		
2- to 4-micron thermal infrared photography	6		1	6		1			
8- to 14-micron thermal infrared photography	7		2	7		2			
Side-looking radar (SLAR) imagery	8		3	8					
Electro-optical (television) imagery									
Imaging microwave imagery	5	5		5	5		5		
Nonimaging scatterometer									

Target identification requirements—Continued

Hot springs (temperature variation of .5°, salt deposits)			Lakes (40 acres and larger)			Land use											
						Commercial (40- by 80-ft buildings, parking areas)			Industrial (40- by 80-ft buildings, storage areas, railspurs)			Institutional (60- by 100 ft buildings)		
Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night
Low	High		Low	High		Low	High		Low	High		Low	High	
4	1		1	1		1	1		1	1		2	1	
5			2	3		3	4		2	4		1	4	
6	2		3	2		2	2		3	2		3	2	
7			4	4		4	3		4	3		4	3	
2		2	7	7	2	6		1	6		3	6		1
1		1	6	6	1	7		2	7		1	7		2
			8	8	3	8		3	8		2	8		3
3		3	9	9	4									
			5	5		5	5		5	5		5	5	

Target identification requirements—Continued

Linearities			Minerals exploration (roads, tailing piles, small buildings, trenching)			Mining activities (roads, tailings, support buildings, railways)			Outcroppings			Physiography (100 ft)		
Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night
Low	High		Low	High		Low	High		Low	High		Low	High	
1	1		1	1		2	1		2	1		2	1	
3	4		3	5		1	4		1			4		
4	3		4	3		3	2		4	4		5	4	
2	2		2	2		4	3		3	2		3	2	
6		1	6		1	6		1				8		3
7		2	7		2	7		2				7		2
8		3	8		3							1		1
5	5		5	4		5	5		5	3		6	3	
												9		4

Sensor	Target identification requirements—Continued								
	Pipelines (clearing activity, pump stations, stream crossings)			Petroleum exploration (roads, drill pads, towers, settling ponds)			Pollution		
							Air		
							Source (2 ft, temperature variation)		
	Daylight		Night	Daylight		Night	Daylight		Night
	Low	High		Low	High		Low	High	
Black and white photography	1	1		2	1		1		
Color photography	3	4		1	4		4		
Infrared (IR) color photography	4	3		3	2		6		
Black and white infrared photography	2	2		4	3		5		
2- to 4-micron thermal infrared photography	6	6	1	6		1	3		2
8- to 14-micron thermal infrared photography	7	7	2	7		2	2		1
Side-looking radar (SLAR) imagery	8	8	3	8		3			
Electro-optical (television) imagery									
Imaging microwave imagery	5	5		5	5		7		
Nonimaging scatterometer									

Sensor	Target identification requirements—Continued								
	Pollution—Continued						Power generation (building shape, stacked fuel storage, switch yards, powerlines, heat)		
	Water—Continued								
	Identity[5]			Source (tone, temperature)					
	Daylight		Night	Daylight		Night	Daylight		Night
	Low	High		Low	High		Low	High	
Black and white photography	3	2		3	1		1	1	
Color photography	1	5		1			2	4	
Infrared (IR) color photography	2	1		2			3	2	
Black and white infrared photography	4	3		4			4	3	
2- to 4-micron thermal infrared photography	7		2	7		2	6	6	1
8- to 14-micron thermal infrared photography	6		1	6		1	7	7	2
Side-looking radar (SLAR) imagery							8		3
Electro-optical (television) imagery									
Imaging microwave imagery	5	4		5			5	5	
Nonimaging scatterometer									

[5]Gross identity only; that is, chemical pollution, thermal pollution, and sedimentation.

Target identification requirements—Continued

Pollution—Continued

Air—Continued				Land				Water		
Distribution (tone changes)[4]		Relative density (tone gradation)[4]		Identity (10 ft, temperature reflectivity)		Location (50 to 100 ft)		Distribution (tone, temperature)		
Daylight	Night	Daylight	Night	Daylight	Night	Daylight	Night	Daylight	Night	
Low High		Low High		Low High		Low High		Low High		
2 1		2 1		3 1		2 1		2 1		
1 2		1 2		1 3		1 4		1 2		
				2 2		3 2		3 3		
				4 4		4 3		4 4		
				7	2	7	2	7	2	
				6	1	6	1	6	1	
				8	3	8	3			
3 3		3 3		5 5		5 5		5 5		

[4]Not an established capability.

Target identification requirements—Continued

Quarries (deep excavation, road or rail services, handling equipment)		Radio transmitters (antennas, footings, clearings)		Railroads					
				Track gauge (12 in. or better)		Location (25 ft, curve radii)		Switches (1 ft for confirmation, presence implied at 10 ft)	
Daylight	Night	Daylight	Night	Daylight	Night	Daylight	Night	Daylight	Night
Low High		Low High		Low High		Low High		Low High	
2 1		1 1		1 1		1 1		1 1	
1 4		2 4		4		3 4		2	
3 2		3 2		3		4 3		3	
4 3		4 3		2		2 2		4	
6	1	7	2	7	2	8	3		
7	2	8	3	8	3	7	2		
8	3	6	1	6	1	6	1		
5 5		5 5		5		5 5		5 2	

Sensor	Target identification requirements—Continued									
	Railroads—Continued						Rangelands (lack of linearities, gross area, photographic IR reflectance)			
	System sophistication (control structures, laybys, signal spacing, 1 to 100 ft)			Trackage (10 ft or better)						
	Daylight		Night	Daylight		Night	Daylight		Night	
	Low	High		Low	High		Low	High		
Black and white photography	1	1		1	1		3	1		
Color photography	2			2	3		2	4		
Infrared (IR) color photography	3			3	2		1	2		
Black and white infrared photography	4	2		4	4		4	3		
2- to 4-micron thermal infrared photography	7		2	7		2	6		1	
8- to 14-micron thermal infrared photography	6		1	6		1	7		2	
Side-looking radar (SLAR) imagery	8						8		3	
Electro-optical (television) imagery							9			
Imaging microwave imagery	5			5	5		5	5		
Non-imaging scatterometer							10		4	

Sensor	Target identification requirements—Continued									
	Roads—Continued			Rock types			Sand and gravel pits (excavation, conveyors, classifiers, stock piles)			
	Width (5 ft)									
	Daylight		Night	Daylight		Night	Daylight		Night	
	Low	High		Low	High		Low	High		
Black and white photography	1	1		2	1		4	1		
Color photography	3	4		1	4		1	4		
Infrared (IR) color photography	4	3		3	2		2	2		
Black and white infrared photography	2	2		4	3		3	3		
2- to 4-micron thermal infrared photography				6		1	6		1	
8- to 14-micron thermal infrared photography				7		2	7		2	
Side-looking radar (SLAR) imagery				8						
Electro-optical (television) imagery										
Imaging microwave imagery	5	5		5	5		5	5		
Nonimaging scatterometer										

Target identification requirements—Continued

Roads												
Barriers			Constriction (10 ft)			Roadcuts			Geographic location (25 ft)			Surface material (tones)[6]		
Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night
Low	High		Low	High		Low	High		Low	High		Low	High	
1	1		1	1		3	1		1	1		1	1	
2	4		2	5		1	3		2	4		2		
3	2		3	3		2	2		3	3		4	4	
4	3		4	2		4	4		4	2		3	3	
			6		1	6		1	8		3			
			7		2	7		2	7		2			
6		1	8		3				6		1			
5	5		5	4		5	5		5	5		5	2	

[6]Multiband and multisensor records preferred to single sensor output.

Target identification requirements—Continued

Sea state (10 ft or better, reflected signal intensity)			Sewage processing (settling ponds, thickness, outflow, evident pollution)			Shorelines			Siphons (canal interruption)			Snow pack		
												Conditions		
Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night
Low	High		Low	High		Low	High		Low	High		Low	High	
2	2		2	1		5	3		2	1				
4			3	4		4	4		3	4				
5			1	2		1	1		1	2				
3			4	3		2	2		4	3				
9		4	7		2	7	7	2	7		2			
8		3	6		1	6	6	1	6		1			
7		2	8		3	8	8	3	8		3			
10						9	9	4					1	
6	3		5	5		3	5		5	5				
1	1	1												

Sensor	Target identification requirements—Continued								
	Snow pack—Continued			Soil					
	Distribution			Moisture					
				Areal distribution			Local difference		
	Daylight		Night	Daylight		Night	Daylight		Night
	Low	High		Low	High		Low	High	
Black and white photography	1	1		3	3		3	3	
Color photography	2	4		5	5		5	5	
Infrared (IR) color photography	3	2		1	1		1	1	
Black and white infrared photography	4	3		2	2		2	2	
2- to 4-micron thermal infrared photography	7	7	2	6		1	6		1
8- to 14-micron thermal infrared photography	6	6	1	7		2	7		2
Side-looking radar (SLAR) imagery									
Electro-optical (television) imagery	8	8	3	8		3	8	6	3
Imaging microwave imagery	5	5		4	4		4	4	
Nonimaging scatterometer									

Sensor	Target identification requirements—Continued								
	Storm effects (visible damage, soil moisture, stream analysis)			Vehicles (type)[7]			Vessels		
							Hull (15- by 50-ft min)		
	Daylight		Night	Daylight		Night	Daylight		Night
	Low	High		Low	High		Low	High	
Black and white photography	1	1		1	1		1	1	
Color photography	3	4		2			2	4	
Infrared (IR) color photography	2	2		3			3	3	
Black and white infrared photography	4	3		4			4	2	
2- to 4-micron thermal infrared photography	7		2	6			6		1
8- to 14-micron thermal infrared photography	6		1	7			7		2
Side-looking radar (SLAR) imagery							8		3
Electro-optical (television) imagery	8		3						
Imaging microwave imagery	5	5		5			5	5	
Nonimaging scatterometer	9								

[7]Truck, sedan, tractor, bus, and so on. Manufacturer and year not specified.

Target identification requirements—Continued

Soil—Continued						Stream Channels					
Texture			Type			Depth (Water penetration)			Location			Obstructions		
Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night
Low	High		Low	High		Low	High		Low	High		Low	High	
1	1		1	1		1	1		3	1		2	1	
4	5		4	5		3	3		1	3		1	4	
3	3		2	3					2	4		3	2	
2	2		3	2					4	2		4	3	
7		2	6		1									
5	4		5	4		2	2		5	5		5	5	
6	6	1	7		2									

Target identification requirements—Continued

Vessels—Continued			Water											
Wake (25 ft)			Absolute temperatures			Currents (surface patterns temperature differences)			Relative temperatures			Supply and treatment (settling ponds, pipelines, pump and (or) treatment building)		
Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night	Daylight		Night
Low	High		Low	High		Low	High		Low	High		Low	High	
1	1					2	1					2	1	
3	4					1	4					4	4	
4	3					3	2					1	2	
2	2					4	3					3	3	
6		1	2	2	2	7	7	2	2	2	2	7		2
7		2	1	1	1	6	6	1	1	1	1	6		1
												8		3
						8	8	3	3	3	3			
5	5					5	5					5	5	

Sensor	Target identification requirements—Continued				
	Water—Continued				
	Velocity (6 in. to 1 ft, wakes from obstructions)			Wells (storage tanks, lush plant growth)	
	Daylight		Night	Daylight		Night
	Low	High		Low	High	
Black and white photography	1	1		2	1	
Color photography	4			1	4	
Infrared (IR) color photography	2			3	2	
Black and white infrared photography	3			4	3	
2- to 4-micron thermal infrared photography				7		2
8- to 14-micron thermal infrared photography				6		1
Side-looking radar (SLAR) imagery				8		3
Electro-optical (television) imagery						
Imaging microwave imagery	5			5	5	
Nonimaging scatterometer						

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