CHANGE DETECTOR

GIMRADA announces that a Change Detector being designed and fabricated by the [redacted] will be delivered in May 1964. This device will compare two sets of aerial photography taken of the same geographic area at different times and quickly indicate the changes or differences between them. There is urgent need for a Change Detector as an aid for the revision of maps and for use in up-dating terrain intelligence data. The intelligence analyst can locate the changes much more quickly and accurately than he can by the time-consuming process of visually comparing the details on the two sets of photography.

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After the two strips of transparencies have been threaded into the Change Detector, the corresponding areas of the two sets will be correlated automatically then scanned simultaneously with a flying spot scanner. In effect, the two views will be compared point by point as they are scanned in a manner similar to that of a television camera. The scene will be shown on a TV monitor screen with the changes clearly indicated as very light or very dark areas. Although its primary purpose is to indicate changes, the Change Detector will have several other capabilities which will be useful to photo interpreters, such as image enhancement, variable magnification from 5X to 40X, and two monitors which will show the scene with changes prominently displayed, the flicker comparison, the reference (initial) scene, or the comparison (latest) scene. Although this equipment has been designed and built primarily for the purpose of detecting differences between two sets of aerial photography, it could also be used with radar and infrared imagery.

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FIRST DRAFT

TESTS FOR CHANGE DETECTOR

1. RESOLUTION
2. FRAME COUNTER ACCURACY
3. MEASUREMENT ACCURACY WITHIN FRAME
4. DISTORTION
5. X-Y MOVEMENT
6. ORIENTATION
7. CONTRAST
8. SIGNAL/NOISE RATIO
9. SHADOW AND CLOUD REJECTION
10. CORRELATION (Image Matching)

    Time Required - Manual

    Time Required - Automatic

    Overlap Limitations
11. AUTOMATIC GAIN CONTROL
12. TIP AND TILT ADJUSTMENTS
13. SPEED OF FILM TRANSPORT
14. SCALE ADJUSTMENT
15. OPTICS
16. RADIATION
17. DURABILITY

1. RESOLUTION

A. Design Goal - 50 lines/mm at maximum magnification.

B. Method of Measurement:

Put standard resolution pattern in Change Detector. Determine the resolution on the screen at normal magnification and maximum magnification.

C. Required Imagery:

Standard resolution pattern on film, and possibly on glass, too.

2. FRAME COUNTER ACCURACY

A. Design Goal: For 250-foot roll with frame length over 5.5 inches, error less than 1 frame. For 250-foot roll with frame length of 2-1/4 inches, maximum error of 5 frames at end of roll.

B. Method of Measurement: The above limitations are based on a maximum error of .01 inch in the measurement of frame lengths.

(1) Set in the distance from frame to frame.

(2) Run a roll of film through the Change Detector, counting the frames.

(3) Compre frame counter total with actual number of frames in the roll.

(4) Repeat this procedure for several format sizes.

C. Imagery Required:

(1) 250-foot roll of film with frames evenly spaced throughout the roll.

(2) One roll of each of any special formats that might be used. (100-foot rolls could be used. Error should probably be expressed per 100 foot of film.)

3. MEASUREMENT ACCURACY WITHIN FRAME

A. Design Goal:

Nearest 1/4 Mm (.01 inch)

B. Method of Measurement: Measure distances between two points on a frame on the film using the cross-hairs in the Change Detector. Do this for points within the normal square format size and also on a long frame where the film must be moved across the aperture to get from the first point to the second. Compare these measurements with those taken by another method of known high accuracy.

C. Imagery Required: Square grid pattern will be convenient to use.

4. DISTORTION

A. Design Goal:

Not specific.

B. Method of Measurement: Put a square grid pattern into the aperture and display it on the monitor. Measurement can be made on the screen surface to check the distortion of the squares. The screen can also be photographed to have a pictorial record of any distortions.

C. Imagery Required: Grid made up of 1/4-inch squares.

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5. X-Y MOVEMENT

A. Design Goal.

B. Method of Measurement: Use comparative cover which is centered over different point and check whether X and Y movements are made properly, using either the manual or automatic procedures.

C. Almost any comparative cover aerial photography will be satisfactor for this.

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6. ORIENTATION

A. Design Goal:

$\pm 90^{\circ}$ for reference and input films.

B. Method of Measurement.

Films of the same area, oriented in opposite direction, will be placed in the two apertures. Since the image in each channel can be optically rotated $\pm 90^{\circ}$, correlation should be readily accomplished for any possible differences in orientation of the films.

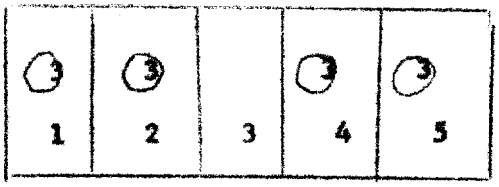
C. Imagery Required:

Aerial photography which can be put into the apertures with various orientations.

9. ~~———————~~ CONTRAST

Method of Measurement. Measure the sensitivity of the Change Detector to small differences in contrast. Make a reference transparency of a 10-step gray scale. Make a reference transparency of the gray scale with "changes" by placing pieces on the 3rd-level scale on 1, 2, 4 and 5 and the 8th-level scale on 6, 7, 9 and 10. They should show up as changes if the sensitivity is to contrast is sufficient. This should also be done using a 20-level gray scale.

Imagery Required - As described above.



~~EMGCM-IN~~

~~26 May 1964~~

8.

SIGNAL/NOISE RATIO

Method of Testing: Use oscilloscope to measure the amplification of the video signal. Measure amplitude of both the signal and the noise, peak to peak. Compute the ratio: $\frac{\text{Signal (volts)}}{\text{Noise (volts)}}$

This ratio will vary with the area covered; full aperture will give better ratio than small area will. Obtain $\frac{S}{N}$ for several areas and plot on a curve:

$\frac{S}{N}$ vs. area.

(Film with high base density will give more noise.) Ratio will vary with the contrast. To standardize, use black pattern. Ratio is highest then.

Imagery Required: Black on white checkerboard test pattern.

Comments: S/N ratio can vary considerably depending on the method of measurement, contrast, base density. S/N measured by RMS (root mean square) is about 2.8 times the S/N obtained by the peak-to-peak method.

8

9 ~~10~~. SHADOW AND CLOUD REJECTION.

A. Design Goal: Not specific.

B. Method of Measurement:

(1) Rejection of shadow and cloud differences being displayed as changes is generally desirable as these differences are usually not significant. Circuitry has been incorporated to "clip" any changes darker than a certain level for shadows or brighter than a certain level for clouds. Shadows are generally the darkest parts of an airphoto, although this is not always true.

(2) Put comparative cover with shadow differences into the apertures. Display the changes without any clipping. Then adjust clipping level so shadow differences are eliminated. Check on the effect this has on other changes.

(3) Check this using "average" photography where the ground features are not very dark and also where very dark features are present, such as irrigated fields in arid areas at certain times of the year.

(4) Also put comparative cover with clouds on one set into the apertures. Display the changes without any clipping. Then adjust clipping level so the "white" cloud differences are eliminated. Check on the effect this has on other changes.

(5) Adjust both the light and dark clipping levels until the dispaly screen shows nothing but changes.

C. Imagery Required:

(1) Comparative cover with "normal" range of gray scales, no extremes.

(2) Comparative cover with some extremely dark field patterns such as irrigated fields in arid areas at certain times of the year.

10. CORRELATION

A. Design Goal

(1) 2 min. for first frame

(2) 30 sec per frame (worst case)

B. Method of Measurement

(1) Put comparative cover into Change Detector. Initial alignment is performed manually, while viewing the two scenes on the monitors. Tilt and focus adjustments must be made. Then final correlation can be made automatically. On the following frames, alignment will probably be close enough so these manual steps will not be necessary. Check the time required to make the initial orientation and correlation and also check the subsequent frames without the initial manual alignment that is generally required on the first frame.

C. Imagery Required:

Comparative cover of several sites with various relations of orientation, scale, and overlap.

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11.4 AUTOMATIC GAIN CONTROL

Imagery Required. Transparency with gray level steps.

Method of Testing. Put the gray level scale into the aperture. Move the film from the light to dark areas and vice versa. AGC supplies a constant video signal to the monitor, so the brightness on the screen should remain approximately the same. No specific values to be measured on this.

~~50 + 11 Supplies constant video signal to monitor~~

12. TIP AND TILT ADJUSTMENTS

A. Design Goal

Tip - $\pm$ 5° along flight line

Tilt - $\pm$ 5° laterally

B. Method of Measurement

(1) Check to make sure this manual control works properly in all four directions.

(2) Measure the angle when the movement is at its maximum in the four directions

C. Imagery Required:

No special imagery required

13. SPEED OF FILM TRANSPORT

A. Design Goal, two ranges:

0 to .2 in/sec (1.0 ft/min)

0 to 24 in/sec (120 ft/min)

B. Method of Testing:

Slow Range - Run 10 feet of film at maximum speed, should take 10 minutes.

Fast Range - Run 120 feet of film at maximum speed, should take 1 minute.

C. Required Imagery

120 foot roll of film (minimum). No special imagery is required.

14. SCALE ADJUSTMENT

A. Design Goal:

Images can be correlated if scale of one film is 2 times the scale on the other.

B. Method of Measurement

Place comparative cover in the aperture which has different scales on the two coverages and correlate the images, both automatically and manually. Do this several times with different scale factors from 1.0 to 2.0 between the coverages.

C. Imagery Required:

(1) Test pattern at several different scales

(2) Aerial photographic coverage of a site at several different scales.

15. OPTICS

A. Design Goal: Not Specific

(Resolution of image on the screen is to be 50 lines/mm at maximum magnification with respect to transparency. No specific figures for the optics alone.)

B. Method of Measurement

(1) The resolution of the optics can be measured between each film and the CRT scanner. Resolution pattern will be placed in film plane, and a microscope properly positioned and focussed at the CRT. The resolution will be read through the microscope. This will be done for each channel.

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(2) Specifications for the lenses will be obtained from [redacted] The objective lenses are commercial lenses; the condensing lenses were made to order.

C. Imagery Required:

Resolution pattern.

16. **RADIATION**

Further information must be obtained from the security office on the required limitations and testing procedures. Federal Standard 222 has been prepared for radiation limitations of communications equipment. There seems to be less chance of video signals being reconstituted than other types of communication signals at the same radiation level.

17. DURABILITY

A. Design Goal

It is desired that the Change Detector be able to operate continuously for considerable periods of time, for an 8-hour shift at least.

B. Method of Measurement

(1) Check for durability after all other tests have been

25X1A completed. Obtain from [redacted] the manufacturer what the expected life of the CRT is.

(2) Operate the Change Detector continuously for an 8-hour day for two days. Obtain the normal characteristics of CRT's: what effect does it have on the active life of a CRT if it is operated continuously for long periods of time or for many periods of one or two hours? Make sure all the various components are used frequently during the test period. This test should be made after all the other tests are completed as failure of components are most likely to occur during this time.

C. Imagery Required:

Long rolls of comparative cover.

Item 8: Signal to Noise Ratio

Peak voltage = 1.414 x RMS

Peak-to-peak V = 2.828 x RMS

RMS voltage = 0.707 x Peak $= \frac{\text{Peak}}{1.414} = \frac{\text{Peak}\sqrt{2}}{\sqrt{2}\times\sqrt{2}} = \frac{\text{Peak}\sqrt{2}}{2}$

RMS voltage = 0.3535 x peak to peak voltage

$= \frac{P\text{-}P}{2.828} = \frac{P\text{-}P}{2\sqrt{2}} = \frac{\sqrt{2}\,PP}{2\sqrt{2}\times\sqrt{2}} = \frac{\sqrt{2}\,PP}{4} = \frac{1.414\,PP}{4}$

Many of the tests can use the same input "Matrix"?

	Frame 1	Frame 2	Frame 3
Test 1	L R		
" 2		L R	
" 3	L R		
etc			

Item 11: Use same input as Item 7 ?

What is "5K+" supplies constant ... ?

Item 13

B Slow range ... at ~~maximum~~ minimum speed, ...?

Mark film with footage (Magic Marker)

Item 14

Same imagery but copied at different scales

Item 16: !

Item 17: Can be done by having a PI use the Detector for several 8-hr days (leave on at noon).

Make a "log" (determine format) for a record of operation.

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Enclosure 1

CHANGE DETECTOR TESTS -- Summary

	Item	Design Goal
1.	Resolution:	50 lines/mm at max. (40) magnification
2.	Frame Counter Accuracy:	250 ft roll with 5.5" or over frames, <1 frame 250 ft roll with 2 ¼" frames, <5 frames
3.	Measurement Accuracy Within Frame:	± mm (approx. 0.01")
4.	Distortion:	Not specified
5.	X-Y Movement:	Not specified
6.	Orientation:	± 90° for each input film
7.	Sensitivity:	Not specified
8.	Signal/Noise Ratio:	Not specified
9.	Shadow and Cloud Rejection:	Not specified
10.	Correlation:	First frame: 2 minutes Suceeding frames: 30 seconds
11.	Durability:	Not specified
12.	Tip and Tilt Adjustments:	Tip : ±5° along flight line Tilt : ±5° laterally
13.	Film Transport:	Slow range: 0 to 0.2 IPS (1.0 FPM) Fast range: 0 to 24 IPS (120 FPM)
14.	Scale Adjustment:	Ratio between images of not more than 2:1
15.	Optics:	Not Specified
16.	Human Engineering:	Not specified.

TESTS FOR CHANGE DETECTOR

1. RESOLUTION
2. FRAME COUNTER ACCURACY
3. MEASUREMENT ACCURACY WITHIN FRAME
4. DISTORTION
5. X-Y MOVEMENT
6. ORIENTATION
7. SENSITIVITY
8. SIGNAL/NOISE RATIO
9. SHADOW AND CLOUD REJECTION
10. CORRELATION (Image Matching)
11. DURABILITY
12. TIP AND TILT ADJUSTMENTS
13. FILM TRANSPORT
14. SCALE ADJUSTMENT
15. OPTICS
16. HUMAN ENGINEERING
17. Magnification

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☐ SECRET ☒ CONFIDENTIAL ☐ UNCLASSIFIED 25X1A

CONTRACT INSPECTION REPORT

CONTRACT NO. [redacted] TASK NO. 25X1A

TO:

CONTRACT ADMINISTRATION & SETTLEMENT
BRANCH/PD/OL

DATE 21 March 1966

INSPECTION REPORT NO. *(If final, so state)* 23

ESTIMATED COMPLETION DATE 15 May 1966

[redacted] 25X1A

TYPE OF COMMODITY OR SERVICE

P. D. Charge Detector Prototype

THE CONTRACTOR IS ON SCHEDULE ☐ YES ☒ NO

PER CENT OF WORK COMPLETED - 100 %

PER CENT OF FUNDS EXPENDED - 100 %

THE CONTRACTOR WILL PROBABLY REMAIN WITHIN ALLOCATED FUNDS ☒ YES ☐ NO IF ANSWER IS "NO" ADVISE RECOMMENDATION AND/OR ACTION OF SPONSORING OFFICE, ON REVERSE HEREOF. IF KNOWN, INDICATE MAGNITUDE OF ADDITIONAL FUNDS INVOLVED.

HAS AN INTERIM REPORT, FINAL REPORT, PROTOTYPE, OR OTHER END ITEM BEEN RECEIVED FROM THE CONTRACTOR DURING THE PERIOD? ☐ YES ☒ NO *(If yes, give details on reverse side.)*

HAS GOVERNMENT-OWNED PROPERTY BEEN DELIVERED TO CONTRACTOR DURING THIS PERIOD? ☐ YES ☒ NO *(If yes, indicate items, quantity, and cost on reverse side.)*

INCENTIVES

IS THIS AN INCENTIVE CONTRACT ☐ YES ☒ NO

IF YES, CHECK TYPE ☐ COST ☐ PERFORMANCE ☐ DELIVERY

NOTE:
USE REVERSE SIDE FOR COMMENTS.
FINAL REPORT MUST CONTAIN INCENTIVE EVALUATION.

OVERALL PERFORMANCE OF CONTRACTOR

1. ☐ OUTSTANDING
2. ☐ EXCELLENT
3. ☐ ABOVE AVERAGE
4. ☒ AVERAGE
5. ☐ BELOW AVERAGE
6. ☐ BARELY ADEQUATE
7. ☐ UNSATISFACTORY

IF OVERALL PERFORMANCE OF CONTRACTOR IS UNSATISFACTORY OR BARELY ADEQUATE, INDICATE REASONS ON REVERSE SIDE.

RECOMMENDED ACTION

☒ CONTINUE AS PROGRAMMED

☐ WITHHOLD PAYMENT PENDING SATISFACTORY PERFORMANCE

☐ TERMINATE

☐ OTHER *(Specify)*

IF TERMINATION IS RECOMMENDED OR IF THIS IS A FINAL REPORT PUT COMMENTS ON REVERSE IN NARRATIVE FORM ON CONTRACTOR'S PERFORMANCE AND CERTIFY THAT ALL DELIVERABLE ITEMS UNDER THE CONTRACT HAVE BEEN RECEIVED. THESE INCLUDE, WHERE APPLICABLE, THE FOLLOWING:

ITEM	REC'D	DOES NOT APPLY	ITEM	REC'D	DOES NOT APPLY
PROTOTYPES			MANUALS		
DRAWINGS AND SPECIFICATIONS			FINAL REPORT		
PRODUCTION AND/OR OTHER END ITEMS			SPECIAL TOOLING		
			OTHER GOVERNMENT PROPERTY		

DATE OF LAST CONTACT WITH CONTRACTOR 21 March 1966 (TELECON)

25X1A [redacted]

DIVISION

SIGNATURE OF APPROVER

FORM 10-65 1897 USE PREVIOUS EDITION ☐ UNCLASSIFIED ☒ CONFIDENTIAL ☐ SECRET (12-36)

NARRATIVE REPORT ☐ INTERIM ☐ FINAL

In a telephone conversation on 21 March '66, the [redacted] Project Engineer, [redacted] 25X1A 25X1A stated that the Maintenance Manual would be forwarded in approximately one week. Final acceptance must await receipt of that document.

[redacted] 25X1A

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[redacted] 25X1A

1100 wods. - 6/11/66

[redacted] 25X1A

[redacted] 25X1A