Data Acquisition Brief

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A Digital Display Camera-Exposure-Interval Comparator

The preceding camera exposure interval is shown in seconds on a static display while in an adjacent position a dynamic display shows the accumulating seconds of the current exposure interval.

OVERVIEW

FIXED EXPOSURE station aerial photography requires the camera operator to trigger a camera exposure manually when the aircraft is directly above a predetermined exposure location by visually interpreting the ground below in relation to the exposure station shown on a flight map. Occasionally, the exact ground location of the exposure station may not be recognizable due to the lack of discrete ground data over certain types of terrain such as bodies of water, deserts, heavily forested areas, and new urban developments. At these times, a reasonable accurately placed exposure may be triggered by using the same "real time" exposure interval as that established by a recent previous exposure pair which the camera operator triggered by positive ground terrain identification.

PROBLEMS AND SOLUTIONS

A conventional approach to the lack of visual identification for certain exposure stations has been to use a stopwatch to time an exposure interval at the beginning of the flight line and to use this interval for reference later on when an exposure station cannot be identified. This method may be found satisfactory for short lines, but it can lead to problems on longer flight lines.

The "real time" exposure interval varies during long flight lines even though the true ground distance between exposure stations remains the same. This occurs because the aircraft ground speed changes due to varying wind velocity and direction and due to aircraft weight and attitude changes from fuel burnoff. Ground speed variations of 10 percent have frequently been observed on flight lines of 50 miles or longer. On a hypothetical flight line in which the aircraft ground speed is 150 mph, the negative scale is 1:20,000, and the exposure station spacing is one mile, the exposure interval would be 24 seconds. If the ground speed were to change by 10 percent, use of the 24-second interval would result in missing the next exposure station by 528 feet and the station after that by 1,056 feet. The longer the inaccurate interval is used by the camera operator, the greater the error becomes.

When using the stopwatch method it is difficult to measure and revise the reference interval frequently because the camera operator is occupied with other duties: flight line navigation, crab adjustment, camera level monitoring and adjustment, as well as searching the ground for the next exposure station.

DESCRIPTION OF COMPARATOR

A digital display camera-exposure-interval comparator has been developed to help the camera operator overcome these problems. The device presents two seven-segment LED (Light Emitting Diode) numeric displays, each capable of indicating up to 99 seconds. The static display shows the immediately preceding camera interval, while the

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dynamic display shows the elapsed time of the current camera interval in one-second increments. When the camera operator is unable to identify ground data for the next exposure station, he may refer to the display and trigger the exposure when the two intervals are the same.

An additional benefit of this device is that the camera operator, and the pilot when a remote display is positioned within his sight, can see how much time remains until the next exposure and can better judge if there is sufficient time to make course and altitude corrections.

The main unit of the interval comparator is in a 2½ by 6 by 6½ inch case and can be placed in a convenient location so that the display is easily viewed by the camera operator (Figure 1). The remote display case measures 1½ by 4 by 4½ inch and can be similarly mounted within the pilot's vision. Power for the unit is supplied by the aircraft 28-volt system and is taken from the same location as the camera power.

Circuit Design and Theory

The digital circuit design utilizes CMOS integrated circuit chips to minimize power consumption to less than one ampere. The unit is powered by a regulated 12 volt system. Filtering to inhibit voltage spikes is provided for all power supply lines.

Electronic theory of operation is based on relatively simple digital logic (Figure 2). The camera exposure signal is transmitted to the interval comparator through a 28-volt relay connected in parallel with the exposure signal lamp of the camera control unit. Use of the relay provides electrical isolation from the camera system as a safety precaution.

The relayed camera pulse is made bounce-free and then triggers two 10-millisecond one-shot pulses in series with 10 milliseconds delay between them. The first pulse provides a latch signal to the static display decoders, causing the static displays to freeze the count at the time of exposure. This display shows the operator the interval in seconds between the previous pair of exposures. The second pulse clears the active display decoders and active displays and also resets the counters to "00." The clock continues to increment the counters at one-second intervals so the active displays show the elapsed time since the last camera exposure.

Summary

The comparator has been field tested on a project consisting of 13,000 line miles of predetermined regularly spaced exposure centers in northwestern Wisconsin. Specific ground identification by the camera operator of plotted exposure centers was often obscured by dense forests. Reliance upon

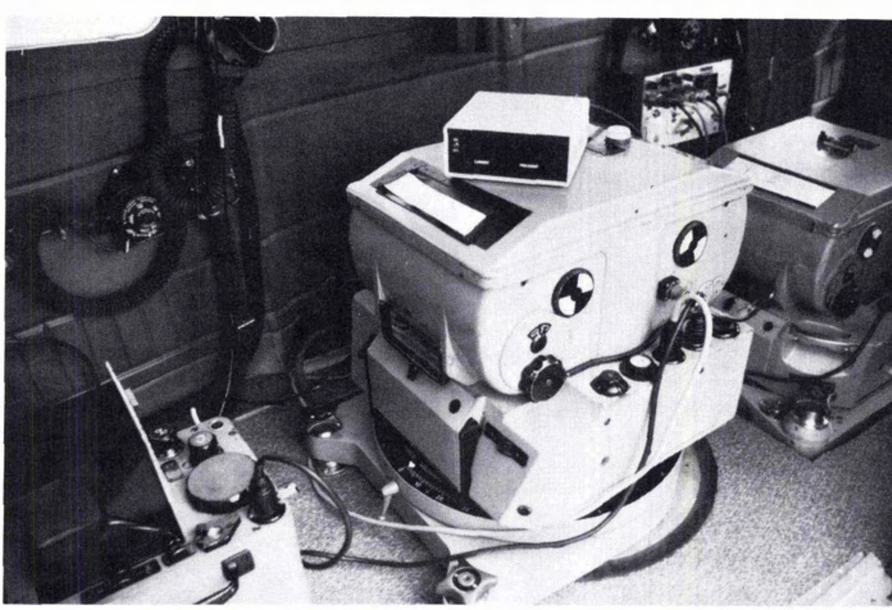

FIG. 1. The exposure interval comparator placed on a Zeiss magazine and camera in Chicago Aerial Survey's Cessna 207. The operator sits to the left, out of the picture.

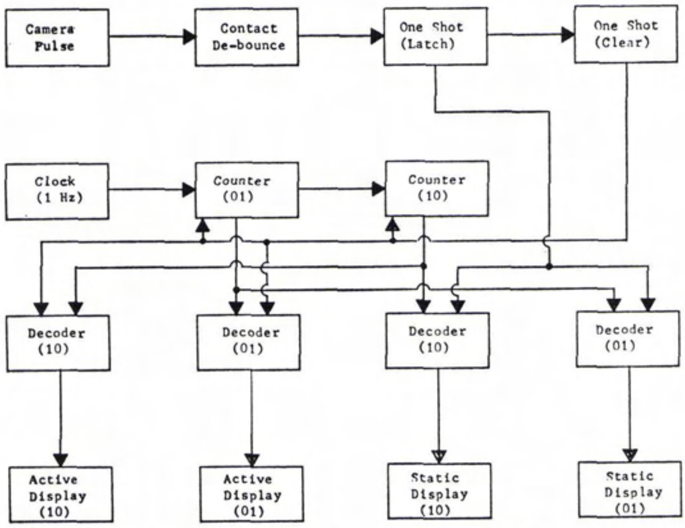

FIG. 2. The logic block diagram for the digital display camera-interval-exposure comparator.

the exposure comparator in these situations resulted in a significantly lower percentage of missed exposure centers due to the lack of terrain identification.

On this project the camera operator served as the primary navigator responsible for requesting course corrections necessary to maintain the aircraft's position over the 150 mile long flight lines. The information supplied by the comparator concerning the time remaining until the next exposure allowed a better judgment to be made about when to initiate course corrections so as to prevent exposures during periods of aircraft heading changes.

It is envisioned that the pilot's remote display will also prove valuable as an aid in keeping the aircraft level at the instant of exposure during more conventional series overlap photo projects by providing time available for course correction information.

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