NASA TECH BRIEF

NASA Pasadena Office

Technique Minimizes the Effects of Dropouts on Telemetry Records

The problem:

To minimize the effects of recorder deficiencies in telemetry systems which process digital data.

The solution:

Use a two-channel system to prepare two tapes, each of which has the noise, wow and flutter, and dropout characteristics of the channel on which it was made; process the tapes by a computer which combines the signals from the two channels to produce a single tape free of the dropouts caused by the recording process.

How it's done:

The telemetry signal is processed by a two-channel system, each having an analog tape recorder, dropout detector with identification logic circuits, and a digital tape recorder (magnetic tape, etc.). Identical timing reference signals are fed to each channel.

The dropout detector monitors noise and dropout events. Since the timing reference signal is subjected to the same distortion as the data when reproduced, compensation can be achieved by using the reference signal for data sample timing. The timing reference signal is a sine wave and its zero crossings are utilized as sampling commands. The reference signal may however be further corrupted by noise and tape dropouts which may produce erroneous sample commands, or no sample commands, respectively.

As an example of the operation of the dropout detector, consider a 10-kHz reference signal and a 3.6-MHz clock pulse; the clock interval is thus a one-degree time interval. The clock-pulse count is started at a zero crossover of the reference signal, and within a few more crossovers, the number of counts in a typical crossover interval is established (within an error Δ); then, it is possible to predict the number of counts (that is, the time interval T) when the next crossover should occur. Assume that crossover points occur at $t_0, t_1, t_2, \ldots t_n$ and that the sample times t_0 and t_1 have been established. Then, t_2 is predicted as follows:

$$t_1 + T - \Delta \leq t_2 \leq t_1 + T + \Delta.$$

If the detection of a crossover appears at t_2, then t_3 is predicted in the same manner. However, if t_2 is detected as follows:

$$t_2 \leq t_1 + T - \Delta,$$

the event is registered as noise and $t_1 + T - \Delta$ is used instead of the detected value of t_2 to compute t_3. A special word appears on tape instead of digital data. On the other hand, if t_2 is detected as:

$$t_2 \leq t_1 + T + \Delta,$$

the event is registered as a dropout and $t_1 + T + \Delta$ is used in place of t_2. A special word appears on the tape instead of digital data.

Accounting for discrepancies due to wow and flutter is accomplished by predicting that the next cycle (T_2) of the reference signal is $T_1 + \Delta$; T_2 may therefore be accepted if

$$T_1 - \Delta \leq T_2 \leq T_1 + \Delta.$$

The device which implements the logic for wow and flutter also tracks frequency changes, and when they occur too abruptly (as during noise bursts and dropouts) it will smooth the changes. In the absence of crossover points it will supply the last detected rate so that when the signal reappears it is likely to be within acceptable limits.

(continued overleaf)

The two digital tapes obtained as records from the two-channel system now contain rectified information as processed by the dropout detection system. The digital tapes are best combined using a digital computer algorithm. The key to combining the tapes is that the records are essentially identical when no dropouts occur. Synchronization can therefore be obtained by cross correlating the data on the two tapes. The length of time to synchronize thus depends on the uncertainty in the synchronization. To speed initial acquisition, in the original analog recording process the timing signal is supplied to both recorders simultaneously, after recording is started. The initial uncertainty is therefore minimal. The uncertainty should also be minimal after a dropout because the dropout detector supplies approximate timing information.

In combining the two possibly corrupted data records into one good record, the average of the two data points is used when no dropout occurs. Only the good value is used when a dropout is detected. Only the values from one tape are used for several sampling times immediately preceding and following a dropout on the other recording. The reason for this is that the phenomenon causing the dropout may also cause degraded data on adjacent tape.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103
Reference: TSP72-10088

Patent status:

No patent action is contemplated by NASA.

Source: Tage O. Anderson and
William J. Hurd of
Caltech/JPL
under contract to
NASA Pasadena Office

(NPO-11421)