TO: USI/Scientific & Technical Information Division
Attention: Miss Winnie H. Morgan

FROM: GP/Office of Assistant General Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned U. S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code USI, the attached NASA-owned U. S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U. S. Patent No.: 3,567,861
Government or Corporate Employee: U. S. Government
Supplementary Corporate Source (if applicable): N/A
NASA Patent Case No.: KSC 10002

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

Yes □ No X

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of Column No. 1 of the Specification, following the words "... with respect to an invention of ..."

Elizabeth A. Carter
Enclosure
Copy of Patent cited above
Fig. 1.
Fig. 2.
A video sync processor which includes a phase locked loop which compares the horizontal sync of an incoming video signal to the horizontal sync of a local sync generator and thereby locks a voltage control oscillator of the processor to a master oscillator carried in the remote transmitting station. In this manner all local processing equipment is referenced to the remote master oscillator. Frequently, when signals are received from remote stations, such as spacecrafts, there is a low signal-to-noise ratio and the quality of the signal is poor. In order to improve the stability of the composite signal the sync and blanking portion are stripped from the incoming video signals and a clean sync and blanking signal from the local sync generator is inserted therein. Therefore, as long as horizontal phase-lock is maintained all ground recording and monitoring equipment are presented with video and clean sync regardless of the signal-to-noise ratio of the signal received.
VIDEO/SYNC PROCESSOR

The invention described herein was made by employees of the U.S. Government, and may be manufactured and used by or for the Government for Governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to a video/sync processor, and more particularly to a processor which will improve the stability of a video signal received from a remote station, such as a spacecraft, so that such can be monitored or recorded for subsequent playback. One of the problems in receiving video signals from remote stations, such as satellites or space vehicles, is that frequently the received signal exhibits a low signal-to-noise ratio. This interferes with presenting a usable video signal to local TV monitors and tape recorders. A system is therefore required which can maintain synchronism over an extremely wide range of input signal levels.

In accordance with the present invention, it has been found that difficulties encountered in processors for receiving remote video signals may be overcome by providing a novel system which removes the vertical and horizontal sync portions from the composite remote video signal and substitutes a new clean sync signal portion therefore. This system includes the following basic parts: (1) a sync separator, (2) a voltage controlled oscillator coupled to the input of the local sync generator for providing an input signal therefor, (5) a phase detector coupled to the output of the sync separator for receiving the horizontal sync portion of the remote composite signal, (6) a voltage controlled oscillator coupled to the output of the sync separator for generating an output signal indicating the frequency difference between the horizontal sync and the sync portion of the remote signal, (7) a phase detector indicating the frequency difference between the local horizontal sync and the sync portion of the remote signal, (8) means for coupling the signal indicating the frequency difference to the video amplifier for changing the frequency of the voltage control oscillator to make the local sync generator come back in phase with the horizontal sync portion of the remote signal, (9) a video switcher having input means for receiving the blanking pulses, the sync signals, and the remote composite signal, and, (10) means for coupling the local sync and blanking signals from the sync separator to the video switcher for combining the local sync and blanking signals with the video portion of the remote composite video signal. The means for coupling the signal indicating the frequency difference to the video control oscillator includes a loop filter which makes it possible for the local sync generator to automatically assume a locked condition with the remote video input almost instantaneously after the loss of sync signal occurs and such reappears.

Accordingly, it is an important object of the present invention to provide a video sync processor which is capable of processing and improving reception of a composite video signal received from a remote station.

Another important object of the present invention is to provide a video sync processor which is capable of processing and improving reception of a composite video signal received from a remote station.

Still another important object of the present invention is to provide a video sync processor which automatically assumes a locked condition between a local sync generator and the sync portion of a remote video signal under extreme variations in input signal-to-noise ratio.

Still another important object of the present invention is to provide a video sync processor which is very flexible and is capable of improving reception of composite video signals which have an extremely large dynamic range of signal levels.

Other objects and advantages of this invention will become more apparent from a reading of the following detailed description and appended claims taken in conjunction with the accompanying drawings wherein:
present a better understanding of such. The divider chain 25 is composed of a divide by 7 block 26, a divide by 5 block 27, another divide by 5 block 28, and a divide by 3 block 29. These blocks are shown tied together by leads 30, 31 and 32, respectively, so that if a 31,500 Hz signal is applied at one end a 60 Hz signal is produced at the lower end. It is noted that the reset pulse coming in on lead 24 is also fed into each of the di-

10 ver blocks. Thus, when a reset signal comes in on lead 24 it is fed to the appropriate divider block to reset the sync generator to its initial condition when the signal being fed over lead 23 into the vertical phase comparator is not in phase with the remote vertical sync signal coming into the phase comparator 20 over lead 19. Therefore, the local and remote signals are maintained in vertical phase synchronism. It is, also, extremely important that the horizontal sync signal produced by the local sync generator 22 be in phase-lock with the horizontal sync portion of the remote signal so that all the ground recording and monitoring equipment can be slaved to the remote master oscillator and be presented with a video signal having clean sync regardless of the signal-to-noise quality of the received signal. In order to accom-6

modate such, a circuit constructed in accordance with the present invention includes a second order phase-locked loop, generally designated by the reference character 33. When a loss of signal occurs, it is possible for the second order phase-locked loop 33 to automatically reacquire a locked condition almost instantaneously without a slipping cycles when the remote signal reappears. This fast acquisition can be assured for a properly designed second order loop if the frequency difference between the remote input signal and the loop voltage control oscillator 34 does not exceed the phase-locked loop pull in range and the maximum rate of change of the input signal does not exceed the loop bandwidth. Since the looped bandwidth is a function of input signal-to-noise ratio, the lock-in range of the loop will decrease with increasing signal-to-noise ratios. Thus, as can be seen, in order to reinsert clean sync to the video signal, the local sync generator 22 must be phase-locked to the video input.

15 Referring to FIG. 1, it can be seen that the signal at junction 17, which includes the horizontal and vertical sync portion of the remote signal is applied to an input 35 of the phase detector 36. A local horizontal sync signal is also applied to the phase detector via lead 37 coming out of the sync generator 22, and the sawtooth generator 38. The output of the sawtooth generator 38 is coupled to the input to the phase detector 36 by means of lead 39. If the signal coming in on lead 39 is in phase with the signal coming in on 35 to the phase detector 36, then there will be no error signal on the output lead 40. This condition of zero phase error takes place when both the local horizontal sync and the remote horizontal sync signals are in phase. The sawtooth generator 38 is sampled at the zero voltage point and no output signal appears when the two signals are in phase.

20 Any difference in the frequencies between the local horizontal sync signal and the remote horizontal sync signal causes a voltage output on lead 40. This voltage output is sent to a loop filter block 41 which establishes the bandwidth of the phase-locked loop. The bandwidth can be changed by changing the value of the resistors 42 and 43. It is noted that the resistor 42 is a series resistor, while resistor 43 is connected in shunt therewith to one side of capacitor 44 which has its other side grounded. An advantage of using a wide bandwidth is that such makes the system more suitable for acquisition and tracking. A narrower bandwidth is used when it is desired to reduce signal jitter under very low signal-to-noise conditions which results in a more stable presentation of the signal to the video monitors and tape recorders. One advantage of using the wide bandwidth is that lock is almost instantaneously accomplished for all but the most abnormal operating conditions.

25 The output of the loop filter 41 is applied by means of lead 45 to the control input of the 31.5 KiloHertz voltage control oscillator 34. The input voltage being applied to the voltage controlled oscillator 34 by means of lead 45 will change the frequency of the oscillator so that, in turn, changes the output frequency of lead 46 which is fed over lead 37 through the sawtooth generator 38 to the phase detector 39 in order to bring the local horizontal sync signal in phase with the remote horizontal sync signal. Therefore, there is a closed loop which maintains the local and remote horizontal sync signals in synchronism. It is necessary that the remote and local horizontal sync signals always be in phase synchronism so that the local sync and blanking can be reinserted in the video switchers at the same place as the original sync and blanking components of the remote signal.

30 As can be seen, the 31.5 KiloHertz signal being supplied from the oscillator 34 is fed via lead 46 into a divider 47 enclosed within the sync generator 22 to divide the signal in half so that a 15,750 Hertz signal is applied on the output lead 37 to be compared in the phase detector 36.

The sync generator 22 also has pulse forming circuits 21 which give out the standard EIA composite sync signal on lead 48, a mixed blanking pulse on lead 49, the horizontal and vertical sync signals, and a 3 horizontal scan line duration vertical pulse on lead 23.

35 The signals coming out of the pulse forming circuits 21 forming a part of the sync generator 22 range from 0 to minus 6 volts, whereas, the sync portion of the remote video signal is approximately 0.3 volt peak to peak, therefore, there has to be an input video sync signal portion and a mixed blanking portion and the local sync portion. One way of doing this is supplying the local composite sync signal and the mixed blanking signal by means of leads 48 and 59 to a DC reference block. A signal which is the average DC level of the remote video signal is supplied from the video amplifier 13 by means of lead 51 to an input of the DC reference block 51 which acts as a reference for reducing the amplitude of the signals coming from the pulse forming circuits 21 so that the local sync and blanking signals are adaptable with the amplitude of remote composite video signals. In other words, the DC reference block 51 uses the average DC level from the video amplifier 13 coming in on line 51a to change the amplitude of the signals coming on lines 48 and 49 from the local sync generator so that on the output line 52 we have a local sync and blanking signal which is compatible both in amplitude and DC level to the input signals being supplied to the video switchers 53, 54 and 55 from the video amplifier 13.

40 The video switchers and decommutators 53 and 54 may be any suitable conventional switcher and are provided for decommutating the remote video signal, as well as reinserting a clean sync and blanking signal into the composite signal. The video switcher 55 only reinserts a clean sync and blanking signal into the composite signal. Frequently, in space vehicles there are more than one camera aboard for monitoring the operation of different components, such as the engines, etc. In order to use a single transmitter the signals are commutated so that the composite signal includes alternate frames from the two cameras. Thus, when the signal is received it is first decommutated and then sent to the desired monitoring station. This is accomplished in the switches 53 and 54. The decommutated remote video signal is fed from the video amplifier 13 by leads 56 and 57 to the video switchers 53 and 54. By alternately switching the video switchers on and off in synchronism with the switching rate of the commutated signal, a decommutated signal is produced at the output of the switchers 53 and 54 on leads 60 and 61, respectively. Clean sync and blanking are reinserted in the decommutated outputs in the same manner as in video switcher 55.

45 The operation of the video switcher and sync reinsertor 55 will be discussed first. The composite video signal is applied from the amplifier 13 through lead 58 to an input of the video switcher 55. On lead 52 coming into the video switcher 55 is the local sync and blanking signal which is to be substituted for the sync and blank portion of the remote signal coming in on lead 58. Actually, the blank portion referred to in the signal is just the interval between the video information coming in
from the remote station. Thus, it is desirable to not only replace the sync with a clean sync, it is also desirable to make certain no noise or information is carried in the gap or blank the video information. Therefore, a clean blanking pulse is also applied with the local sync. On leads 62 and 63 leading into the video switcher is a blanking pulse and its complement which is used to generate a control logic signal in the switching circuit 55 which, in turn, controls the reinserter of the local sync and blanking signal coming in on lead 52. The blanking signal which is fed in on lead 62 is taken from lead 49 coming from the pulse forming circuit 21 labeled mixed blanking. On lead 62 the blanking signal is inverted first by an inverter 64 to produce the complement of the blank signal on lead 62 entering in the video switcher. The video switcher may be any suitable standard circuit which is capable of blanking a portion of the composite signal so that a clean sync and blanking signal can be reinserter.

At the output of the video switcher 55 a clean composite signal is supplied to lead 65 and is fed into a plurality of emitter followers 66 for being subsequently fed to any suitable monitoring system, such as tape recorders and video monitors, coupled to the output thereof. The video switchers 53 and 54 operate in the same manner as the video switcher 55 except switching pulses are supplied thereto so that they also decommutate the commutated signals coming in on leads 56 and 57 from the video amplifier. If the signal is not a commutated signal, then such would be fed straight through the video switcher 55. Switching signals are supplied over leads 67 and 68 from the decom divider for alternately switching on switchers 53 and 54, respectively. Thus, alternate frames or multiples thereof, will appear on the outputs 60 and 61 of the switchers 53 and 54, respectively. Therefore, only signals produced by one camera will appear at the output of the video switcher 53, while the frames produced by the other camera at the remote station will appear on the output of 54. The rate that the switching operation takes place is synchronized with the cameras at the remote station. A reference voltage is also supplied to the video switchers and decommutators 53 and 54 from the output of the DC reference block 51 over lead 59. The purpose of the reference voltage is to provide a voltage level for the video switcher to return to during the time the camera in which it is monitoring is off. In other words, during the decommutation operation the video switchers 53 and 54 are alternately turned on and off. During the off period, that is, during the period when the particular switcher is not transmitting a video signal therethrough, the switcher is returned to the reference voltage level supplied over lead 59 from the DC reference source 51. The reference level occurs only during each video line interval. Clean sync and blanking are still present in the output during the off camera periods. The DC reference voltage coming in on lead 59 into the video switching decommutators 53 and 54 is an average voltage that is received in the video amplifier 13 and fed by lead 51A to the DC reference 51. The video signals on the output leads 60 and 61 are also fed to emitter followers 66 to be applied to any suitable monitoring apparatus. It is to be understood that the video switchers 53 and 54 operate in the same manner as the video switcher 55 as far as reinserting a clean local sync and blanking pulse is concerned, plus they decommutate the incoming signal, if such is necessary.

A 60 cycle signal is supplied from the base of the divider chain 55 which forms part of the sync generator over lead 70 to the decom divider 69 for use as the decommutating formats. That is, producing the switching signals on the output leads 67 and 68. For the purpose of explaining the operation of such, it is assumed that the remote signals being received includes alternate signals from a pair of cameras A and B carried in the remote space vehicle. As previously mentioned, the decom divider 69 produces signals on its output to alternately switch on and off switchers 53 and 54 so that only signals from the camera A appear on output lead 69 and only signals from camera B appear on output lead 61 from the switchers 53 and 54, respectively. However, in addition to decommutating the signals the switching signals at the output of the decom divider 69 must be in phase correlation. This is accomplished by placing a signal at the beginning of vertical sync portion of the remote signal from camera A. Normally, this signal is a 1/2 megacycle signal superimposed on horizontal scan lines 19, 20 and 21, of camera A. Therefore, it would have a duration of three lines of horizontal scan. This signal is supplied over lead 71 leading from the video amplifier 13 into any suitable conventional burst recognizer 72. The signal is detected in the burst recognizer 72 and generates a pulse output which occurs in time with the 1/2 megacycle signal which is sent at the start of each reference camera vertical format. In this particular example, such is camera A. The output pulse which is generated by the burst recognizer 72 is applied to the output lead 73 to the decom divider 69 to reset the divider if such is out of phase in order to keep the video outputs from video switcher blocks 53 and 54 in synchronism. In other words, this maintains the correct camera signal on each output 60 and 61 so that the two signals from camera A and B are not intermingled.

The 60 cycle signal coming out of the sync generator 22 on lead 70 is also applied by lead 74 to any suitable conventional camera drive circuit 75 which generates a camera drive signal on its output lead 76. The camera drive circuitry 75 filters the 60 cycle signal and generates a sign wave camera drive signal of approximately 5 to 8 volts, which appears on the output lead 76. This is used in television kinescope systems which require a 60 Hertz coherent signal with the video for operating the film camera on a TV kinescope system.

The circuitry has been shown in block form, and any suitable circuit could be used for producing the results obtained by the individual designated blocks.

In summarizing the operation of the video sync processor, it will take a signal from a remote station and remove the sync portion of the signal, as well as the blank portion between the video information signals and substitute a clean local sync and blanking signal therefor. The system will also decommutate any commutated signal coming in, depending upon the format of incoming signals. At any time there is a useful video signal being received there will be horizontal and vertical sync lock due to the second order phase-locked loop.

While a preferred embodiment of the invention has been described using specific terms, such description is for illustrative purposes only, and it is to be understood that changes and variations may be made without departing from the spirit or scope of the following claims.

We claim:

1. A system for removing the vertical and horizontal sync signal portions from a composite video signal received from a remote station such as a space vehicle and reconstructing the signal with a new clean sync portion comprising:
   A. a sync separator;
   B. means for supplying said remote composite signal to said sync separator for separating the horizontal and vertical sync signal portions from said composite signal;
   C. a local sync generator producing local sync and blanking signals;
   D. a voltage controlled oscillator coupled to the input of said local sync generator for providing an input signal therefor;
   E. a phase detector coupled to said output of said sync separator for receiving the horizontal sync portion of said remote composite video signal;
   F. means for supplying said local sync signal to said phase detector to be compared with said horizontal sync portion of said remote composite video signal;
   G. said phase detector generating an output signal indicating the frequency difference between said local sync signal and said horizontal sync portion of said remote signal;
   H. means for coupling said signal indicating the frequency difference to said voltage controlled oscillator for changing the frequency of said voltage controlled oscillator
which makes the local sync generator come back in phase with said remote horizontal sync signal;
I. means for including a loop filter for maintaining the frequency of said voltage controlled oscillator near its normal operating value when said remote signal is temporarily lost;
J. a video switcher having an input means for receiving blanking pulses and sync signals;
K. input means for coupling said remote composite signal to said video switcher;
L. means for coupling said local sync and blanking signals from said sync generator to said video switcher for removing said sync signals from said remote composite video signal and combining said local sync with the video portion of said remote composite video signal;
M. a vertical integrator;
N. a vertical phase comparator coupled to the input of said integrator;
O. means for coupling said remote vertical sync signal portion from said sync separator to said vertical phase comparator through said integrator;
P. means for supplying a local vertical signal from said sync generator to said vertical phase comparator to be compared with said remote vertical sync signal portion; and
Q. means for coupling the output of said vertical phase comparator to said sync generator for resetting said sync generator when said local vertical signal is out of phase with said remote vertical sync signal portion to synchronize said local sync signal with said remote vertical sync signal portion.
2. The system as set forth in claim 1 wherein said remote video signal is a commutated signal and further comprising:
A. a plurality of combined video switchers and decommutators;
B. means for supplying said commutated signal to said combined video switchers and decommutators;
C. means for supplying a switching signal to said combined video switchers and decommutators for causing said remote video signal to be decommutated; and
D. means for coupling said local sync and blanking signals from said sync generator to said combined video switchers and decommutators for cancelling said signals from said remote composite video signal and combining said local sync with the video portion of said decommutated signals.