GENERAL ELECTRIC
COMPANY

COMMAND SYSTEMS
DIVISION

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APOLLO SUPPORT DEPARTMENT

10 March 1965

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Huntsville, Alabama 35812

Attention: Mr. William J. McKinney, PR-RC

Subject: Infrared Measurement in Real Time, Part II
Phase B - NAS8-11715

Dear Mr. McKinney:

In accordance with discussions with Mr. J. R. Mitchell during his visit to our Daytona Beach office on February 17 and 18 and his request for more detailed information on the system previously designated as the Contract System, we submit the attached data in ten (10) copies. This further supplements the information in our letter of February 9, 1965.

In submitting this additional information, we feel it is appropriate that we restate the recommendation made in the above referenced letter and our letter of January 25, 1965, that this Contract System will not achieve the degree of refinement which you wish to achieve and, therefore, would not be in the best interest of either General Electric or NASA. We believe that the system which we recommended in our letter of January 25 should be authorized to accomplish the end result which you wish to obtain.

Reference is made to the Unclassified Technical Report submitted on Phase A as an attachment to my letter of 25 January 1965. In this report in paragraph VII "Recommendations", in subparagraph 1.b "Infrared Optics" there is a typographical error in Sentence 1. Sentence 1 should be revised to read as follows:

GENERAL ELECTRIC

"One lens with 1.0 inches diameter field of view at object focus of 1.0 feet".

In the event you wish to discuss this matter further, please advise.

Very truly yours,

E. G. Butts
Contract Administrator

EGB:sr

Enclosures 10

cc Mr. Elmer Mitchell

IR TELEVISION SYSTEM

FOR FAULT DETECTION

March 3, 1965

Alternate I - Contract System

I. GENERAL DESCRIPTION

The General Electric Infrared Television Camera, Model UAR-252, uses the General Electric Type Z-7808 infrared vidicon tube to image radiation whose wavelengths extend well into the intermediate infrared region of the electromagnetic spectrum. This capability makes an infrared television camera system attractive for many applications including surveillance, measurements, guidance , observing temperature distributions such as hot spots in electronic circuits and investigating thermal properties of materials undergoing heat treatment.

The UAR-252 camera system, as shown in the attached photograph, includes two basic units, the camera head assembly and the control set, described separately below. The camera head contains the infrared vidicon tube and the related electrical components which, when properly energized, produce a video signal, or an electrical readout of the scene imaged on the vidicon target by the lens. The control unit provides electrical excitation for the elements in the camera head. It also provides amplification for the video signals from the camera head with processing required to produce a video signal compatible with standard monitors.

The liquid-nitrogen cryogenic cooling required by the infrared vidicon tube is supplied by an open dewar mounted on the camera head.

A. Camera Head Assembly

March 3, 1965

1. Description

The camera head assembly serves as a container and mount for the infrared vidicon tube, the focus, deflection, and alignment coils, the lens assembly, and the preamplifier. Its housing is a cylindrical aluminum container which is reinforced at three positions along its length to provide a basic structure for support of the component parts and a mounting base. Access to the interior of the camera head from the front may be gained by removing the lens mounting plate assembly. A removable cover permits access to the preamplifier and alignment coil which are located in the rear of the camera head.

The front of the vidicon tube is supported by clamping the tube flange between Textolite rings. The socket end of the tube is held by a compressed "O" ring.

The low-level preamplifier is a magnetically shielded plug-in unit constructed around the vidicon tube socket to minimize lead lengths. Outstanding low-noise performance is obtained by using nuvistors in a cascade arrangement. A cathode follower output permits operation of the camera head assembly at a remote location from the camera control unit.

The electron mulitplier voltage divider is located in the vidicon tube socket, which is a part of the preamplifier module. Three connectors - a coaxial connector for video signals, a high-voltage connector for anode and electron multiplier supply voltages, and a connector for the remaining power, sweep, and control voltages - provide electrical interconnections between the camera head and the control unit.

2. Component Parts

The infrared vidicon camera head assembly includes the following basic components or subassemblies:

a. Z-7808 infrared vidicon tube

b. Preamplifier

c. Deflection coil

d. Alignment coil

e. Focus coil

f. Lens mounting plate assembly

g. Cryogenic dewar with mounting bracket (½-liter approximate capacity)

h. Mounting base for camera head

i. Lens and optical filter assembly as follows:

f/1.2, 2-element IR lens with a germanium filter to limit transmitted radiation to above 1.9 microns. The lens/filter system will have a combined transmission through the longest wave length response of the Z-7808 tube, and will have a field of view of approximately 28 degrees total.

B. Camera Control Set

1. Description

The camera control set includes all of the electronic circuitry to supply the infrared vidicon camera head assembly with the appropriate operating voltages and currents, and to process the resulting video signal from the preamplifier. Solid-state circuitry is employed throughout. All dimensionally suitable components are mounted on welded-wire matrices, providing a type of construction which is inherently rugged, dimensionally stable and maintainable. Larger components are wired point-to-point and held in place by insulated standoffs. If the components have appreciable mass, auxiliary metal or nylon straps are also added to increase control set tolerance to shock and vibration.

Circuits are constructed on modular metal cards to combine ruggedness with maintainability. The cards are guided into the control set housing by slots on two sides and by guide pins adjacent to the connectors on the bottom. If desired, any card can be removed and desk-top maintainence checks performed with power on by using a cheater card with its extension cable. The power supply and drive circuitry are thermally connected to the chassis and cooled by radiation and free convection. Primary operator controls are located on the front panel. Secondary control functions, such as focus and alignment adjustments, are located behind a hinged cover on the control panel.

Input power requirements are 112 watts at 28 volts dc ±10 percent. A series diode is used for protection against reversed input voltage. The input power circuit includes a fuse located on the front panel.

2. Component Parts

The modules or subassemblies in the camera control set and the function of each are as follows:

a. Control Panel - Provides controls and switches for camera operation and adjustment.

b. Video Amplifier - Provides wideband amplification for video signals from the preamplifier. Blanking and sync pulses are also generated and added to produce a composite video signal compatible with standard monitors.

c. Synchronizing Generator - Produces pulses at the vertical rate of 60 cps and the horizontal rate of 15.75 kc for operation of various camera circuits.

d. Vertical Deflection - Produces a trapezoidal sweep voltage for the vertical deflection coils. Combines horizontal and vertical

pulses for blanking the vidicon target in a circuit which also provides sweep failure protection. Includes a focus current regulator circuit.

e. Horizontal Deflection - Produces a sawtooth sweep voltage for horizontal deflection coils and horizontal blanking pulses for the generation of the composite video signal in video amplifier.

f. Power Supply - From a 28 v dc input, this unit produces all regulated voltages for operation of the entire camera. Four power transistors associated with the power supply regulators are located on the back panel.

g. Back Panel - Includes connectors, reverse voltage protection diodes, regulator transistors, and heat radiator.

C. Signal Processor Unit and TV Monitor

1. Description

A single electronic video gate that can be positioned within the TV raster and of a size to enclose the minimum image size (0.02 x 0.02 inches on the tube retina) will be provided. In addition, a video signal integrator circuit will be provided to furnish an output voltage proportional to the average amplitude of the video signal contained within the electronic gate.

This unit will consist of a rack mountable panel and chassis approximately 3 inches high with horizontal and vertical controls for positioning the video gate within the raster.

A standard 17" television monitor designed for rack mounting will be provided.

D. Specifications

1. Camera Head

a. Dimensions

Length (less lens assembly): 19.3 in.

Diameter (housing only): 6 in.

Projection of cold finger beyond housing: 3.5 in.

b. Weight (less cryogenics dewar and lens) 31.5 lb.

2. Camera Control Set

a. Dimensions

Nominal size: 8 in. W x 7.19 in. H x 17.5 in D

Weight: 25 lb.

b. Electrical

Input voltage: 28 v dc $\pm$ 10 percent

Input power: 112 watts

Regulation at output of internal power supply: $\pm$1 percent

c. Video

Output: 1 volt composite

Source impedance: 75 ohms

Bandwidth: 8 Mc $\pm$ 1 db

Tilt: less than 2 percent on 60 cps square wave

DC level setting: keyed clamp

d. Sync Outputs

Vertical: pulse amplitude 5.0 volts
pulse width 1.1 msec.

Horizontal: pulse amplitude 7.5 volts
pulse width 5 u sec.

e. Sweeps

Vertical: 525 lines interlaced 2:1

Field rate: 60 cps

Sweep failure protection: 10 u sec vertical; 50 u sec horizontal

Linearity overall: ±2 percent

Focus current regulation: ±0.25 percent

Alignment: electrical

Front porch: 2 u sec

Sync rise time: 0.2 u sec or less

3. System Performance

The following is an estimate of the performance that could be expected from an IR television instrumentation system as described above.

a. Thermal Resolution -

35°C above ambient

b. Spatial Resolution-

Minimum object size of 3/4" diameter at object distance of 5 feet

c. Optics FOV - 28 degrees

The lens specified is a standard, average quality lens, and certain qualifications regarding the above listed thermal and spatial resolution performance should be noted. This lens is designed to operate at conjugate focii with the object distance at 53.5 inches or greater. Lens aperture respons deteriorates at shorter object distances. Hence, for example, if the object plane is moved into 2.5 feet and the lens is refocused, the spatial resolution will not be 3/8" diameter minimum object size, but will be something greater than that. Simultaneously, the thermal resolution will also deteriorate from 35°C above ambient because of the combined affects of tube aperture response limitations and image energy density spread caused by the lens.

E. Mechanical Mounting

One restriction is placed on the mounting position for the camera head on the basis of the requirements of the infrared vidicon tube itself. The tube may be operated at any position except with the tube socket up and the tube axis at an angle of less than twenty degrees from the vertical. This restriction also applies to handling the tube when it is removed from the camera head.

Six mounting feet are provided on the base plate of the camera control unit, three on each end. The base plate may be bolted to a supporting structure using ¼ inch bolts. The control unit may be operated in any desired position. However, cooling of the back panel by free convection around the fins is reduced somewhat when the fins are not vertical.

F. Electrical Connections

The camera system requires a nominal input power of 112 watts at 28 volts dc based on a current requirement of 4 amps. Actual input current may vary from this value, depending upon the settings of various adjustments in the control unit. A power source capable of delivering approximately 5 amps at 28 v dc ±10 percent is considered satisfactory for use with this camera system

Cables for interconnection of the camera head and control unit are provided including a 75-ohm coaxial cable to carry video signals from the camera head to the control unit. Composite video output signals from the control unit should be connected to the monitor with a 75-ohm coaxial cable which is terminated at the monitor with 75 ohms.

Horizontal and vertical synchronizing voltage pulses are available at BNC connectors located on the back panel of the control unit. They may

be used for synchronizing other circuits or equipment such as monitors and oscilloscopes. These output pulses are capable of driving impedances of 3000 ohms or higher without appreciable loading. The horizontal sync pulse amplitude is approximately 7.5 volts and the vertical pulse amplitude is approximately 5.0 volts.