AN IMAGING INFRARED (IIR) SEEKER USING A MICROPROGRAMMED PROCESSOR

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A recently developed IIR seeker uses a microprogrammed processor to perform gimbal servo control and system interface via a MIL-STD 1553 port while performing the seeker functions of automatic target detection, acquisition and tracking. Although the acquisition and centroid tracking are relatively low computation load seeker modes, the automatic detection mode requires up to 80% of the available capability of a high performance 2900 based microprogrammed processor. With the high speed processing capability available it is possible to implement a digital servo in the same processor using only 5% of the computation capacity. This digital servo includes six modes of gimbal control at the basic processor 60 Hz computation loop plus a 200 Hz rate loop, the latter being transparent to the main seeker functions. These two asynchronous timing loops plus a 50 Hz system interface loop driven from the 1553 port are implemented in the one processor. The fast response required by the rate loop for the rate sensor demodulator inputs also requires an interrupt driven analog data acquisition system. A 4K microcode program driven by eight interrupts implements these functions as well as the other operator and system interfaces.

The eighth interrupt is used to force the processor into special "front panel" code which suspends all other interrupt processing and saves the state of the processor to allow the programmer to view the contents of all registers and memory as well as enter new values and resume normal processor execution at the interrupted location or any other selected location. This programmer debug aid in the hardware coupled with a set of support software including a symbolic cross assembler and a software simulation of the 2900 based processor allow efficient program development and checkout.

This system developed around the microcoded processor required by one of the system tasks has been designed, checked out and flown successfully. Although system complexity was increased significantly by adding the additional functions this approach can be cost effective when the basic computation capacity is already available.
IIR SEEKER MISSILE INTERFACES

SEEKER

ELECTRONICS

TELEMETRY

GUIDANCE

COMPUTER

FROM RECEIVER

TO TRANSMITTER

1553 DATA BUS
REMOTE TERMINAL

DATA LINK

16 CHANNEL
A/D

SERVO I/O

DISPLAY VIDEO

VIDEO FROM IMAGER

GIMBALS

MICROPROGRAMMED
PROCESSOR

INTERRUPTS

CONTROL PANEL

CARTRIDGE TAPE RECORDER

ANALOG & DIGITAL
VIDEO INTERFACE

GIMBALS

DATA LINK

GUIDANCE

COMPUTER
CPU BLOCK DIAGRAM

MICROCODE WORD

| 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9  | 8  | 7  | 6  | 5  | 4  | 3  | 2  | 1  |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Strobes | B Address | A Address | Shift | ALU Dest. | ALU Func. | ALU Source | Cin |

48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25

Spare  Bus Control  Sequencer  Branch Cond.  Int. Inst.

DATA FIELD
CPU PERFORMANCE/REQUIREMENTS

- 2900 BIT SLICE MICROPROGRAMMED PROCESSOR
- 48 BIT WIDE MICROCODE WORD
- 267 NANOSECOND CYCLE TIME
- 4K PROGRAM MEMORY
- 2K SCRATCH PAD MEMORY
- 8 INTERRUPTS

SEEKER INTERRUPTS

SYSTEM INTERRUPTS
- CONTROL PANEL
- A/D COMPLETION

60 Hz MAIN LOOP
- END OF GATE
- END OF FIELD

200 Hz SERVO RATE LOOP
- SAMPLE AZIMUTH DEMODULATOR
- SAMPLE ELEVATION DEMODULATOR

50 Hz GUIDANCE COMPUTER TIMING LOOP
- 1553 INPUT DATA READY
- 1553 OUTPUT DATA READY
ANALOG DATA ACQUISITION

APPLICATION SOFTWARE

DEMODULATOR DATA REQ.

TOP CIRCULAR WAIT LIST

BOTTOM

DATA REQUIREMENTS

A/D

INTERRUPT HANDLER

DATA

INTERRUPT AND DATA

CPU

SCAN RATES

200 Hz RATE LOOP SOFTWARE

D/A AND CURRENT AMPLIFIERS

TORQUE MOTORS

IMAGER

GIMBAL POSITION PICK-OFF POTS

2 AXIS RATE SENSOR

60 Hz POSITION LOOP SOFTWARE

A/D

GIMBALS

TRACK RATES

TRACKER SOFTWARE

INTERFACE

SERVO FUNCTIONS

I/O
FRONT PANEL FUNCTIONS

- READ/LOAD DATA MEMORY
- READ/LOAD REGISTERS
  - CPU
  - I/O ADDRESS
  - MEMORY ADDRESS
  - CONDITION CODE
- READ/LOAD INTERRUPT STATUS
- EXIT/RETURN TO PROGRAM

SOFTWARE SUPPORT

UNIVERSAL SYMBOLIC ASSEMBLER PROGRAM (USAP) → VARIABLE ARCHITECTURE MICROPROCESSOR SIMULATOR (VAMS)

CARTRIDGE TAPE

LISTING

SEEKER