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VPI: Vibration Pattern Imager

A Control and Data Acquisition System for Scanning Laser Vibrometers

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Part I System Overview

The Vibration Pattern Imager (VPI) system was designed to control and acquire data from scanning laser vibrometer sensors. The PC computer based system uses a digital signal processing (DSP) board and an analog I/O board to control the sensor and to process the data. The VPI system was originally developed for use with the Ometron VPI Sensor [1], but can be readily adapted to any commercially available sensor which provides an analog output signal and requires analog inputs for control of mirror positioning. The sensor itself is not part of the VPI system. The principles of operation of scanning laser vibrometer sensors can be found in Reference [2]. A schematic of the VPI system with a generic sensor is shown in Figure 1.
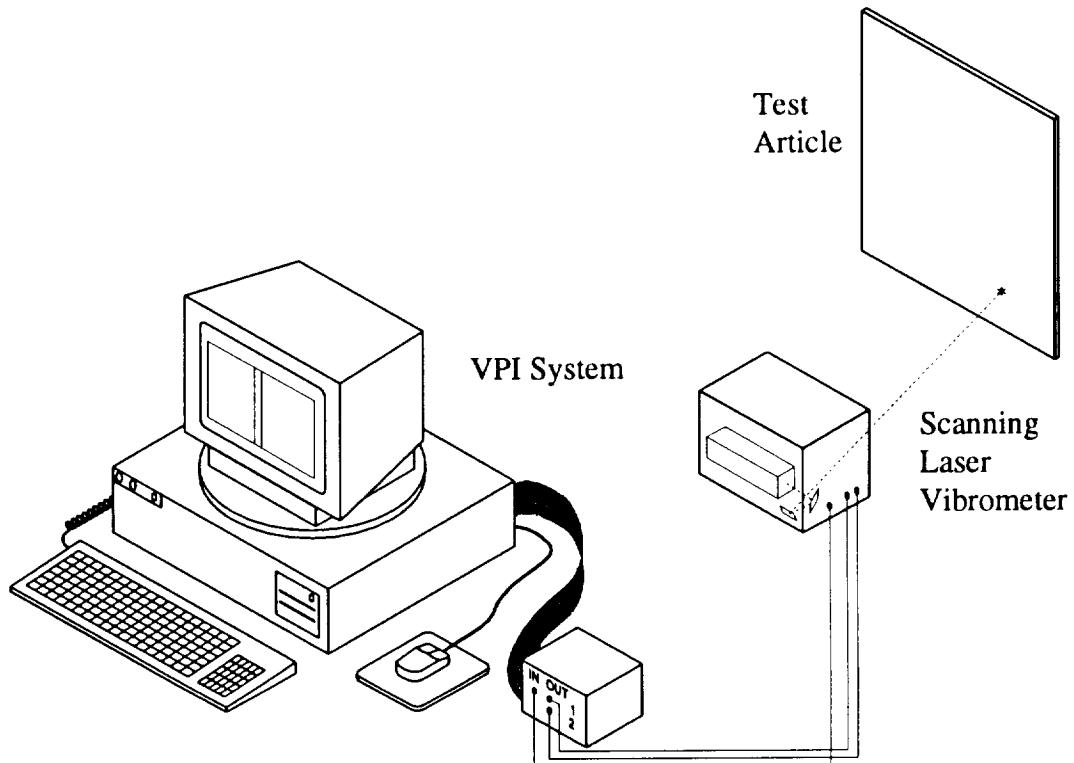
Figure 1: Typical VPI system application.

A graphical interface program, which runs on a PC under the MS-DOS operating system, functions in an interactive mode and communicates with the DSP and I/O boards in a user-friendly fashion through the aid of pop-up menus. Two types of data may be acquired with the VPI system: single point or "full field." In the single point mode, time series data is sampled by the A/D converter on the I/O board (at a user-defined sampling rate for a selectable number of samples) and is stored by the PC. The position of the measuring point (adjusted by mirrors in the sensor) is controlled via a mouse input. The mouse input is translated to output voltages (x and y) by the D/A converter on the I/O board to control the mirror servos. In the "full field" mode, the measurement point is moved over a user-selectable rectangular area with up to 256 positions in each of the x and y directions. The times series data is sampled by the A/D converter on the

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I/O board (at a user-defined sampling rate for a selectable number of samples) and converted to a root-mean-square (rms) value by the DSP board. The rms "full field" velocity distribution is then uploaded for display and storage on the PC.

Part II System Requirements

Hardware

The following hardware is required for the system:

☐ AT/386/486 compatible computer

- Hard Disk (10 MByte or more recommended)
- 640 KByte RAM
- Microsoft compatible mouse
- VGA graphics
- math co-processor (optional)

☐ SPIRIT-30 board

- Sonitech International Inc. Part No. SP30–ISA-256
- Texas Instruments TMS320C30 DSP processor
- 256 KByte zero wait state SRAM
- daughter board with 8 MByte one wait state DRAM (Sonitech Part No. D-SP30–ISA-08)

☐ 4 channel analog I/O board

- Spectrum Signal Processing Inc. Part No. 600–00185
- (4) 12–bit analog inputs (±2.5 V range and 230 kHz throughput)
- (2) 12–bit analog outputs (±2.5/5.0 V range and 300 kHz/channel throughput)

☐ Break-out Box

- (2) single-ended outputs
- (1) single-ended input

Software

The following software is required for the system operation:

☐ PC and SPIRIT-30 executable code
☐ MS-DOS operating system, Version 3.0 or higher
☐ Microsoft mouse driver

Part III System Installation

Hardware

The VPI system hardware is shown in Figure 2. The SPIRIT-30 and analog I/O board plug into two empty ISA slots in the backplane of the AT/386/486 computer. If a 486 computer is used, the clock speed for the ISA bus must be configured to 8 MHz.

The following jumper settings are required for the SPIRIT-30 board:

☐ J1 — J22: factory defaults
☐ Dip Switch Bank SW1 (base address 300, no interrupts)

See Reference [3] for further SPIRIT-30 hardware specific information.

The following jumper settings are required for the analog I/O board:

☐ LK1: base address = 8
☐ LK2: ± 5 volt peak-to-peak (pk-pk) output range
☐ LK3: ± 5 volt pk-pk input range
☐ LK4: position (b)

See Reference [4] for further I/O board hardware specific information.

The following is required of the 50 pin DSPLINK connector between the SPIRIT-30 and analog I/O board:

☐ cut lines #1 and #11 (be sure to properly identify pin 1). *Failure to correctly cut lines #1 and 11 could result in serious damage to the DSP board.*

The following is required for the break-out box:

☐ 25 pin male "D" connector with the following assignments:

- Pin 1: Ground — analog input
- Pin 7: Ground — x control output
- Pin 8: Ground — y control output
- Pin 14: Signal — analog input
- Pin 19: Signal — x control output
- Pin 20: Signal — y control output

The male connector is attached to the analog I/O board. Pins 1 and 14 form the single-ended input; pins 7 and 19, and 8 and 20 form the two single-ended control outputs. All other pins are unused. For the Ometron VPI Sensor [1], the input signal comes from the single ended velocity output connector on the vibrometer head and the two control outputs are connected to the x and y deflection inputs on the rear panel of the electronics unit. Connections for other vibrometer systems are similar, although their locations are likely to vary. *If the input signal exceeds ± 5 volts pk-pk, proper attenuation must be provided by the user to prevent damage to the I/O board.*
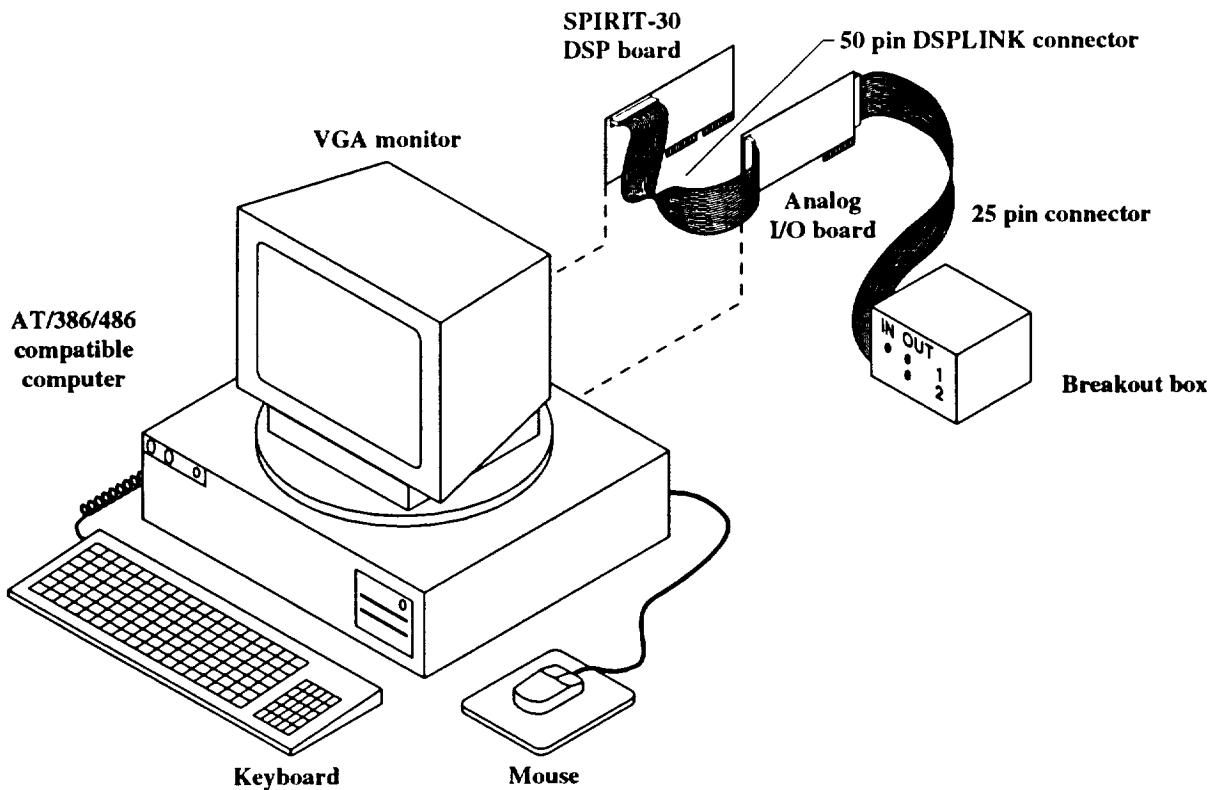
Figure 2: Diagram of VPI system hardware

Software

The VPI software is distributed on a single 3-1/2″ diskette. The directory structure is as follows:

☐ EXE: executable PC and SPIRIT-30 code

☐ C_PROG: C language source code for PC

☐ S30_PROG: TMS320C30 assembly language source code for SPIRIT-30

☐ SAMPLES: sample configuration, geometry, and scan data files

The EXE directory contains the following executable PC and SPIRIT-30 programs:

— VPI.EXE: PC main program
— VPIB.BAT: Batch file to copy executable files to working directory and run VPI.EXE.
— POSTVPI.EXE: PC program for converting scan data from binary to ascii
— LDGEO_30.OUT: DSP program to down-load geometry information from PC
— NOP_30.OUT: DSP program to suspend operation
— PROBE_30.OUT: DSP program to obtain time series data
— SCAN_30.OUT: DSP program to perform scan and compute rms values
— UPRMS_30.OUT: DSP program to up-load rms scan data to PC

The contents of the other directories are discussed later. All files in the EXE directory should be copied to a single directory on the hard disk called VPI. The DSP executable files are never actually run from the PC prompt. They are down-loaded to the DSP board for execution by calls

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made from the PC program VPI. The DSP executable files must reside in the same directory as the PC executable files for proper execution. Therefore, the VPI program must either be run from the VPI directory (by typing VPI), or all the files must be copied to some other working directory. The latter may be accomplished using the batch program VPIB.BAT. There is no need to include the VPI directory in the path.

The mouse driver, mouse.com, must be executed prior to execution of the VPI program. This driver can be run from the AUTOEXEC.BAT file and is copied to the hard disk when the mouse is installed. In general, this driver is supplied by the manufacturer of the mouse. See Reference [5] for information on installing the Microsoft mouse.

Part IV System Operation

The operation of the program is controlled interactively through keyboard and mouse selected menu options. The main menu controls all functions for setup, acquisition, display, file operations, and exiting the program. Sub-menus, which offer additional options, pop-up when a main menu item is selected. All menu options can be selected from the keyboard by typing the letter contained in parentheses ( ) for the particular option. Both upper and lower case letters are acceptable. Selection of the (M)ain Menu item within each sub-menu eliminates the sub-menu and allows the user to select another option from the main menu. The screen for the main menu selection is shown in Figure 3.

Setup Menu

The scan geometry can be defined, stored, and retrieved using the (S)et-up menu options. The screen for the setup menu selection is shown in Figure 4.

Geometry Definition

A rectangular scan geometry may be defined by selecting the (D)efine Geometry menu option. A square positioning box will appear in the left panel as shown in Figure 5. The location of the mouse cursor ($\nwarrow$) controls the current laser position. The mouse cursor position is limited to the region bounded by the positioning box. As the mouse is moved within the positioning box, the x and y positions are displayed and the output control voltages are changed accordingly. The coordinate system is indicated in Figure 5 with the (0,0) or home location positioned at the center of the positioning box. The displayed x and y coordinates are computed using the following relation

$$x = (\bar{x}_m - \bar{x}_b - 128) \times 255, \qquad \bar{x}_b \leq \bar{x}_m \leq \bar{x}_b + 256$$
$$y = (128 + \bar{y}_b - \bar{y}_m) \times 255, \qquad \bar{y}_b \leq \bar{y}_m \leq \bar{y}_b + 256$$

where $\bar{x}_m$ and $\bar{x}_b$ are the horizontal pixel locations of the mouse position and the northwest corner of the positioning box, and $\bar{y}_m$ and $\bar{y}_b$ are the vertical pixel locations. The pixel locations are measured with respect to the northwest corner of the screen and extend to the right and down for the positive $\bar{x}$ and $\bar{y}$ directions, respectively. Values of 20 and 160 are used for $\bar{x}_b$ and $\bar{y}_b$, respectively. The mouse position pixel varies over the 256 $\times$ 256 scan area defined by the positioning box. Thus the northwest corner of the positioning box corresponds to the (x, y) coordinate (-32640, 32640) and the southeast corner of the positioning box corresponds to the coordinate (32640, -32640).

The geometry is defined by specifying the northwest corner and southeast corner of the desired area. A single push of the left mouse button at each location specifies the point. *Note that the northwest corner must be specified before the southeast corner.* The user is then prompted to enter the number of points in the x and y directions. These are integer values between 2 and 256 and are entered using the keyboard. The numbers should be separated by a <space> and followed by a <CR> to accept the values. The output voltages, which control the positioning

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mirror angle, are then computed in equal increments and downloaded to the DSP board. *Note that since the mirrors are positioned in equal angle increments, the change in x and y measuring location on the test structure increases as the beam moves from the center position toward the periphery.* No attempt is made to correct for this effect and the stored geometry and scan data reflect this.

In the present scheme, there is no direct correlation between the displayed coordinates and the physical location of the beam on the test structure. This is due to the fact that each test, in general, has a unique configuration. Instead, the user must determine the particular relationship by simultaneously noting the displayed coordinate and the physical location of the beam. As long as the geometry of the set-up remains constant, this relationship will remain the same.

It is sometimes helpful to write down the x and y corner coordinates in the selection process as this makes the task of redefining the scan geometry easier. New geometries may be defined multiple times within the program, however the current geometry data is destroyed each time the (D)efine Geometry menu option is invoked. There is currently no provision in the software to back out of this option once it has been selected.

Store/Retrieve Geometry

The geometry data may be stored for future use and previous geometry may be recalled using the (S)tore Geometry and (R)etrieve Geometry menu options. In each case, geometry data files are stored in and retrieved from the current working directory unless the full path is specified. The path and file name specification are limited to a total of 80 characters, with the usual limitation of an 8 and 3 character maximum for the file name and its suffix. The geometry data files are stored in binary form to conserve disk space. When the program is quit, an opportunity will be given to the user to save the current geometry if it has been modified since the last (S)tore Geometry operation. A "y" or "n" response (without quotes) , in upper or lower case, followed by a <CR> will permit the user to store the geometry if desired.

Acquire Menu

The acquisition of data is controlled using the (A)cquire menu options. The screen for the acquire menu selection is shown in Figure 6. The acquisition mode (single point or scan) and parameters are selected from within the (A)cquire menu.

Single Point / Time History Mode

The single point mode, used for collecting the time series data, is available by selecting the (T)ime History menu option. When selected, the user is asked to enter a file name, including path if necessary, followed by a <CR> for the storage of the time history data. The path and file name specification are limited to a total of 80 characters, with the usual limitation of an 8 and 3 character maximum for the file name and its suffix. A square positioning box will appear in the left panel as shown in Figure 7. The x and y positions are displayed in the right panel. The mouse is used to position the laser at the desired measurement point in a manner similar to that used for the geometry definition. When the laser is at the desired position, the left mouse button

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is pushed once and the time history is stored to disk. The sampling rate, number of points and calibration factor used are those selected from the (A)cquire menu. These parameters must be selected prior to choosing this acquisition mode if values other than the default are desired. Each line of the file contains the instantaneous time and velocity for a maximum of 8192 samples. An rms velocity is computed from the captured time history and briefly displayed in the right panel. The rms velocity is computed as

$$\sqrt{\frac{1}{N}\sum_{i=1}^{N} v_i^2}$$

where N is the number of samples and v_i is the data at the ith sampling point. The laser vibrometer sensor gives the velocity component of the vibrating structure perpendicular to the laser angle. *Note that no attempt is made to correct for non-perpendicular laser angles as these were determined to produce errors of less than 4% at an angle of 12.5°* [6]. The same is true for measurements made in the scan mode.

Scan Mode

The scan operation is initiated by selecting the (S)can menu option. When selected, the DSP board takes over and controls all operations until the scan is complete. The DSP board scans over the selected area in a zigzag fashion. At each (x, y) location, a user defined pause (the dwell time) is made to allow any mirror vibration to decay. Then, the rms velocity is computed as previously indicated using the sampling rate, number of points and calibration factor selected. The rms velocity distribution is uploaded to the host computer after the scan is complete. An audible beep signals the user when the scan is complete. The only mechanism available to abort a scan once one has initiated is to turn the computer off or reboot the computer and re-execute the program.

Acquisition Parameters

The user has control over the following acquisition parameters: the sampling rate, the number of samples, the calibration factor and the dwell time. The latter is used only in the scan mode.

Sampling Rate The sampling rate is chosen by selecting the Sampling (R)ate menu item. The following may be chosen using the mouse as the input device: 200 Hz, 500 Hz, 1 kHz, 2 kHz, 5 kHz, 10 kHz, 20 kHz, 50 kHz, and 100 kHz. The sampling rate screen is shown in Figure 8. The mouse is positioned near the desired sampling rate, and when the item becomes highlighted, the left mouse button is depressed once to select the item. *The default sampling rate is 10 kHz.*

Number of Samples The number of samples, N, are chosen by selecting the (N)umber of Samples menu item. The following may be chose· or the computation of the rms velocity using the mouse as the input device: 1, 2, 4, 8, 16, 2, 64, 128, 256, 512, 1024, 2048, 4096, 8192. The number of samples screen is shown in Figure 9. The mouse is positioned near the desired number of samples, and when the item becomes highlighted, the left mouse button is depressed once to select the item. *The default number of samples is 1024.*

Dwell Time   The settling time for the mirrors is specified by selecting the (D)well Time menu option. The following options are available: 0 ms, 5 ms, and 7.5 ms. The selection is entered using the keyboard by typing the integer indicated in the parenthesis corresponding to the desired value, followed by a <CR>. The dwell time screen is shown in Figure 10. For the Ometron VPI Sensor [1], a settling time of 4.5 ms is recommended for 90% settled, and 7.5 ms for 99.9% settled. *The default dwell time is 5 ms.*

Calibration Factor   One of three calibration ranges may be chosen by selecting the (C)alibration Factor menu option. The following options are available: (L)ow Range, (M)edium Range and (H)igh Range. The selection is entered using the keyboard by typing the letter (upper or lower case) corresponding to the desired value, followed by a <CR>. The calibration factor screen is shown in Figure 11. *The three calibration factors are: (L)ow: 5.08 V/in/s, (M)edium: 508 mV/in/s, (H)igh: 50.8 mV/in/s. The default range is (M)edium.* These ranges correspond to those given for the Ometron VPI Sensor [1], using the differential velocity output signal. Changing the range in the program only changes the scaling factor. The user is required to manually change the range selection on the instrument to correspond with the new scaling factor.

View Menu

After a scan has been completed, the rms velocity distribution may be displayed using one of the (V)iew menu options. The screen for the view menu selection is shown in Figure 12. Options include setting the display range, plotting the data, zooming in on a particular region of the data, and probing the data to determine the magnitude at a particular point.

Range

The range of the display is set by choosing the (R)ange menu option. Two choices of ranging the display are available: manual and automatic. The range option screen is shown in Figure 13.

Manual Mode   The manual mode is selected by choosing the (M)anual menu option. Once selected, the user is prompted for the lowest expected value of the rms velocity, a real number entered via the keyboard followed by a <CR>. The highest expected value of the rms velocity is similarly entered at the next prompt. The display range is then divided into sixteen levels, corresponding to the sixteen colors of the VGA display. The color bar ranges from the minimum (black) value to the maximum (white) value. The screen for this option is shown in Figure 14.

Automatic Mode   The automatic mode is selected by choosing the (A)uto menu option. Once selected, the data is searched and the lowest and highest values are displayed, as shown in Figure 15. The display range is then divided into sixteen levels, corresponding to the sixteen colors of the VGA display. The color bar ranges from the minimum (black) value to the maximum (white) value. Striking any key on the keyboard will allow the user to continue.

Display Data

The data is plotted in the left panel by choosing the (D)isplay menu option. The plotting of the data can be stopped at any time by pressing the <Esc> key on the keyboard. The size of the plot depends on the number of points in the scan. The entire left panel will be filled by the plot if a 256 × 256 scan was performed; smaller scans occupy proportionately less space. A zoom option, selected from within the (V)iew menu, allows for smaller regions to be blown up. A sample plot is shown in Figure 16.

Zoom Feature

The ability to zoom in on a particular region of the data is enabled by choosing the (Z)oom menu option. The data is first plotted using the (D)isplay option. The mouse is then used to select the northwest and southeast corner of the plotted data in the left panel. *Note that the northwest corner must be specified before the southeast corner.* The selected region is blown up and displayed in the right panel, as shown in Figure 17.

Probe Feature

The ability to probe the data to determine the rms magnitude at a particular point is enabled by choosing the (P)robe menu option. The data is first plotted using the (D)isplay option. The mouse is then positioned on the display at the desired location and the corresponding rms magnitude is simultaneously reported. The right mouse button or <Esc> key is used to exit out of the (P)robe feature.

File Menu

Scan data and configuration information may be stored and retrieved using one of the (F)ile menu options. The screen for the view menu selection is shown in Figure 18.

Save/Retrieve Data

Scan data is saved or retrieved by choosing the (S)ave Data or (R)etrieve Data menu options. In each case, scan data files are stored in and retrieved from the current working directory unless the full path is specified. The path and file name specification are limited to a total of 80 characters, with the usual limitation of an 8 and 3 character maximum for the file name and its suffix. The scan data files are stored in binary form to conserve disk space. The utility program POSTVPI can be used to convert the file to ascii form for post-processing. When the program is quit, an opportunity will be given to the user to save the current scan if a new scan has been acquired since the last (S)ave Data operation. A "y" or "n" response (without quotes) , in upper or lower case, followed by a <CR> will permit the user to store the scan data if desired.

Save/Retrieve Configuration

Configuration information is saved or retrieved by choosing the Save (C)onfiguration File or Retrieve Configuration (F)ile menu options. In each case, scan data files are stored in and retrieved from the current working directory unless the full path is specified. The path and file

name specification are limited to a total of 80 characters, with the usual limitation of an 8 and 3 character maximum for the file name and its suffix. The configuration files are stored in ascii form. The user is not prompted to save the configuration information when quitting the program when changes are made since the last Save (C)onfiguration File operation.

Quit

The program is exited by selecting the (Q)uit menu option. If a scan has been performed or a new geometry defined since the last save operation, an opportunity will be given to the user to save the current scan or geometry before exiting the program. A "y" or "n" response (without quotes) , in upper or lower case, followed by a <CR> will permit the user to store the scan data or geometry definition if desired. The user is finally prompted for a "y" or "n" response to quit in the event the (Q)uit menu option was inadvertently chosen.

Post-Processing

After quitting the VPI program, the binary scan data may be converted to ascii form for post-processing using the utility program POSTVPI.EXE. This program was copied from the EXE directory of the distribution diskette to the VPI directory on the hard disk during software installation. The user is prompted for the binary scan file name and the new ascii scan file name. The scan files are read in and stored to the current working directory unless the full path is specified. The path and file name specification are limited to a total of 80 characters, with the usual limitation of an 8 and 3 character maximum for the file name and its suffix. The data is stored in the three-column format: x position, y position, rms velocity. A two-line header (variable names and zone information) is included in the ascii file so that the data may be plotted using the Tecplot [7] program (available separately). The header may be edited for use with other plotting packages if desired.
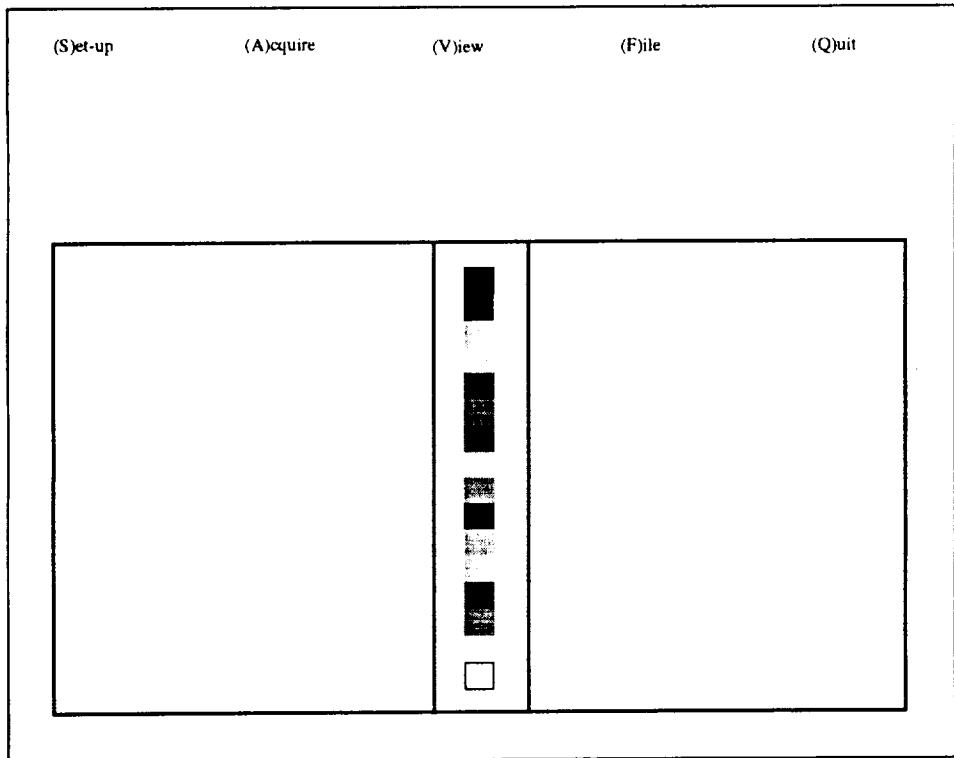
Figure 3: Screen for main menu selection.
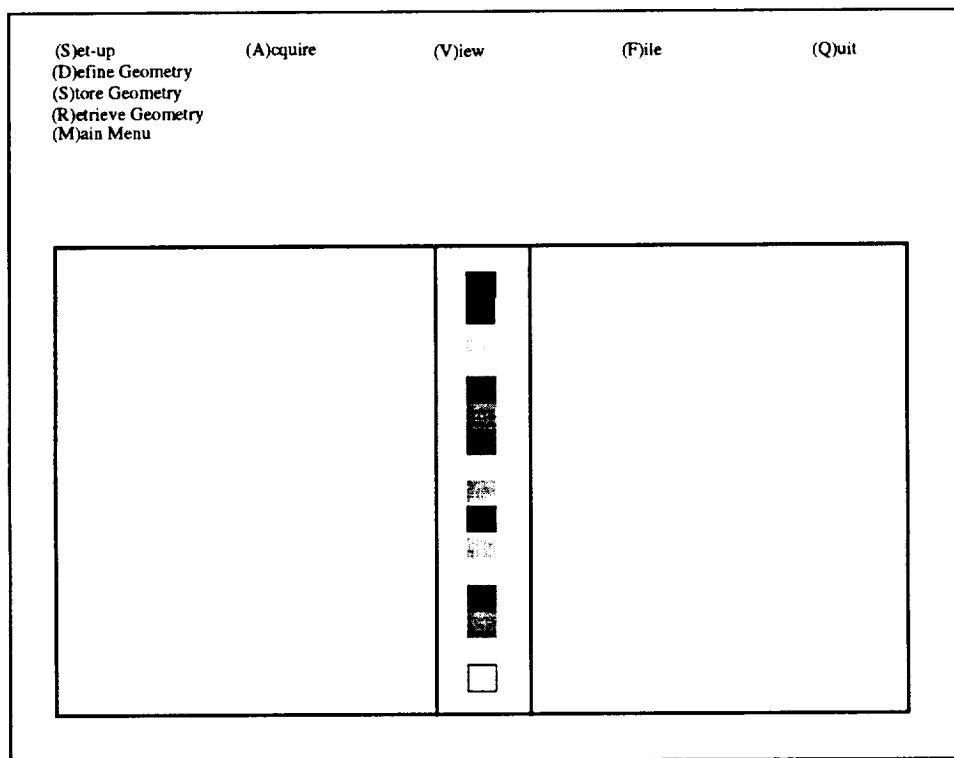
Figure 4: Screen for setup menu selection.
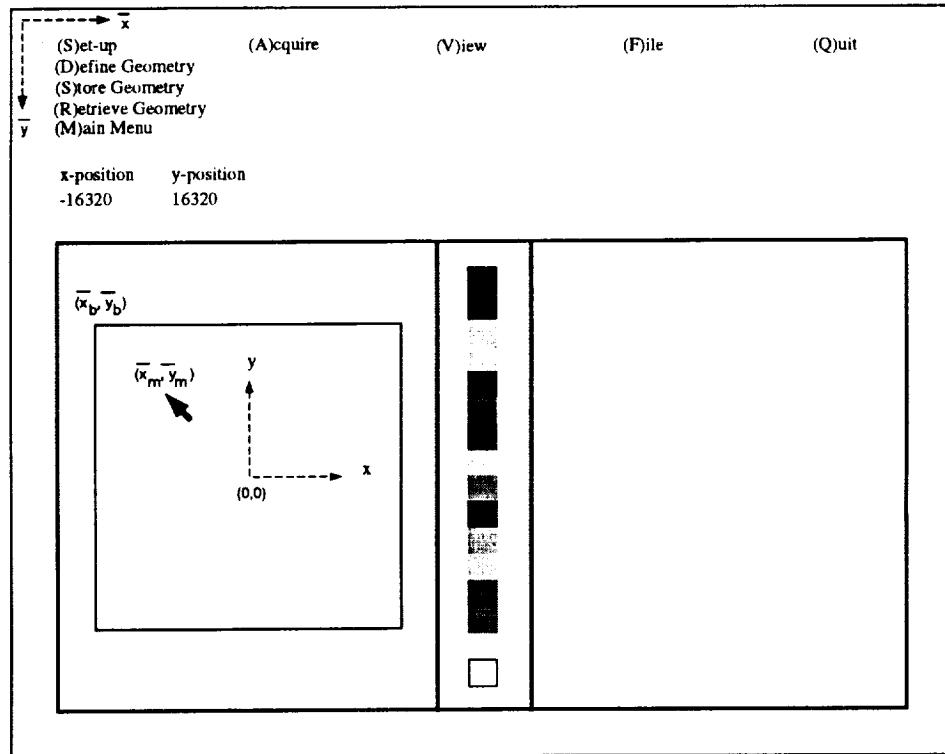
Figure 5: Screen for geometry definition.
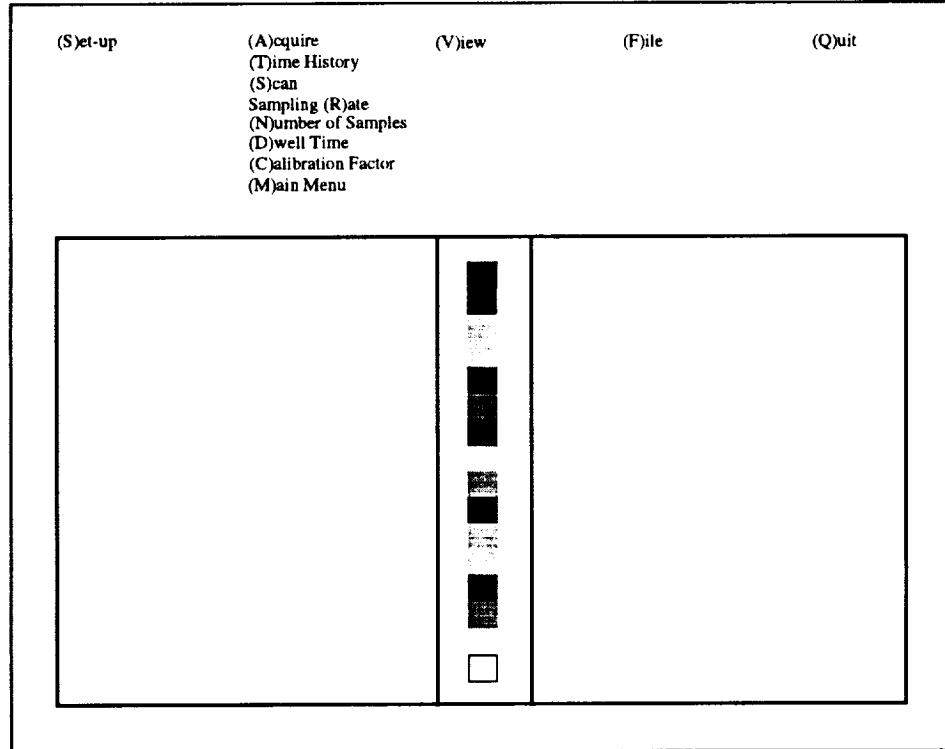
Figure 6: Screen for acquisition menu selection.

(T)ime History
(S)can
Sampling (R)ate
(N)umber of Samples
(D)well Time
(C)alibration Factor
(M)ain Menu

y

x

(0,0)

x - pos: -16320

y - pos: 16320

rms value: 0.2879
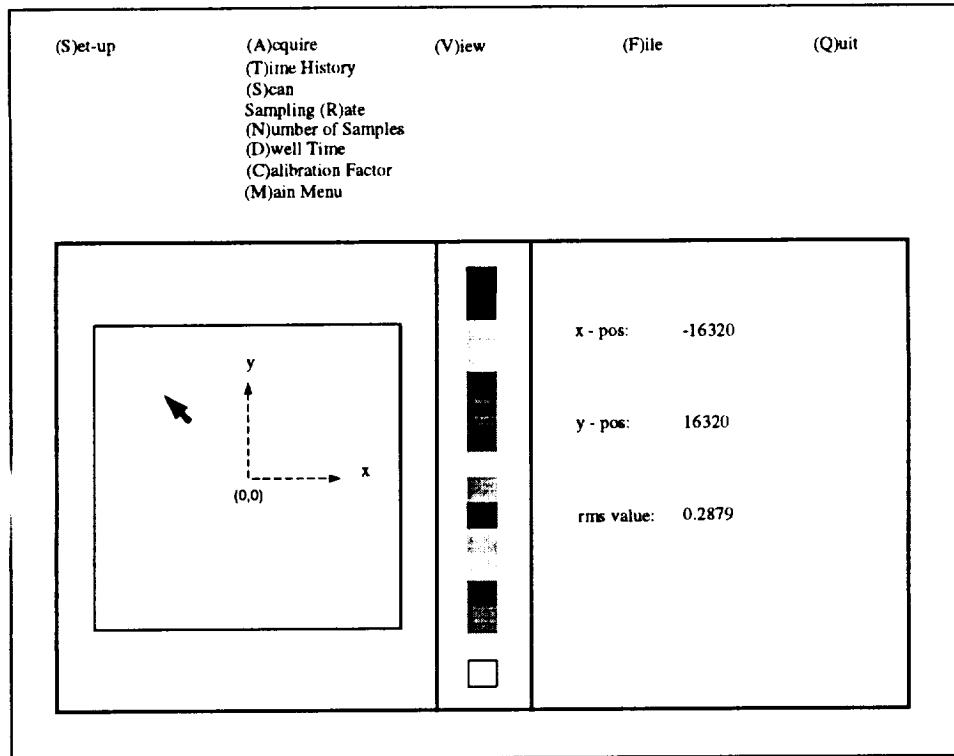
Figure 7: Screen for time history capture.

(S)et-up   (A)cquire   (V)iew   (F)ile   (Q)uit
(T)ime History
(S)can
Sampling (R)ate
(N)umber of Samples
(D)well Time
(C)alibration Factor
(M)ain Menu

200 Hz   500 Hz   1 kHz

2 kHz   5 kHz   10 kHz

20 kHz   50 kHz   100 kHz
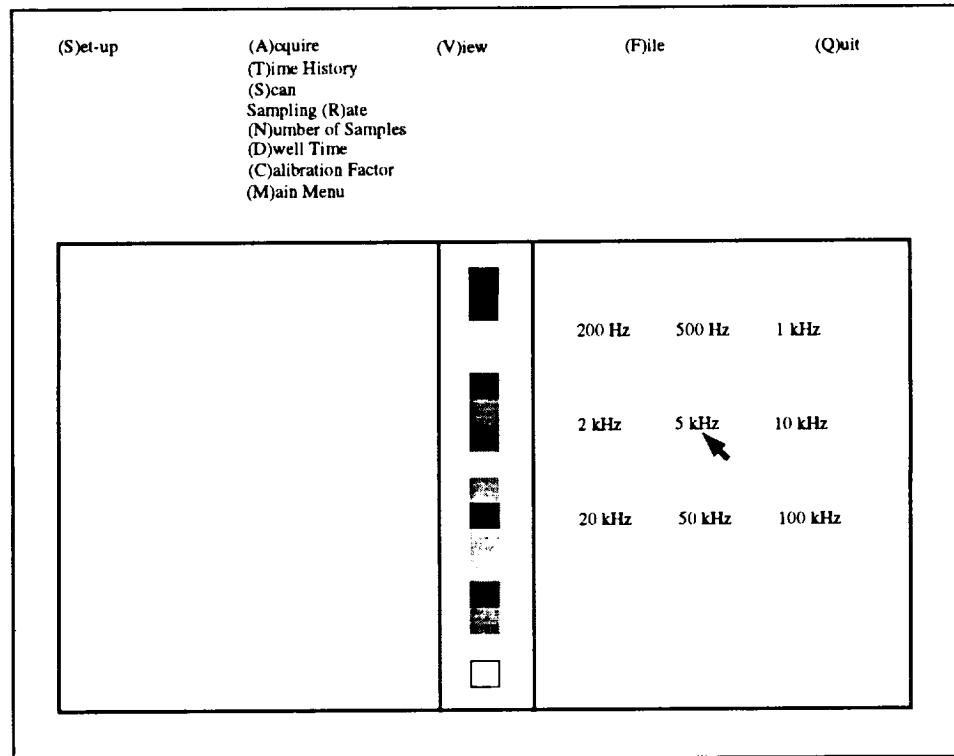
Figure 8: Screen for sampling rate options.

(T)ime History
(S)can
Sampling (R)ate
(N)umber of Samples
(D)well Time
(C)alibration Factor
(M)ain Menu

1	2	4	8	16
32	64	128	256	512
1024	2048	4096	8192	
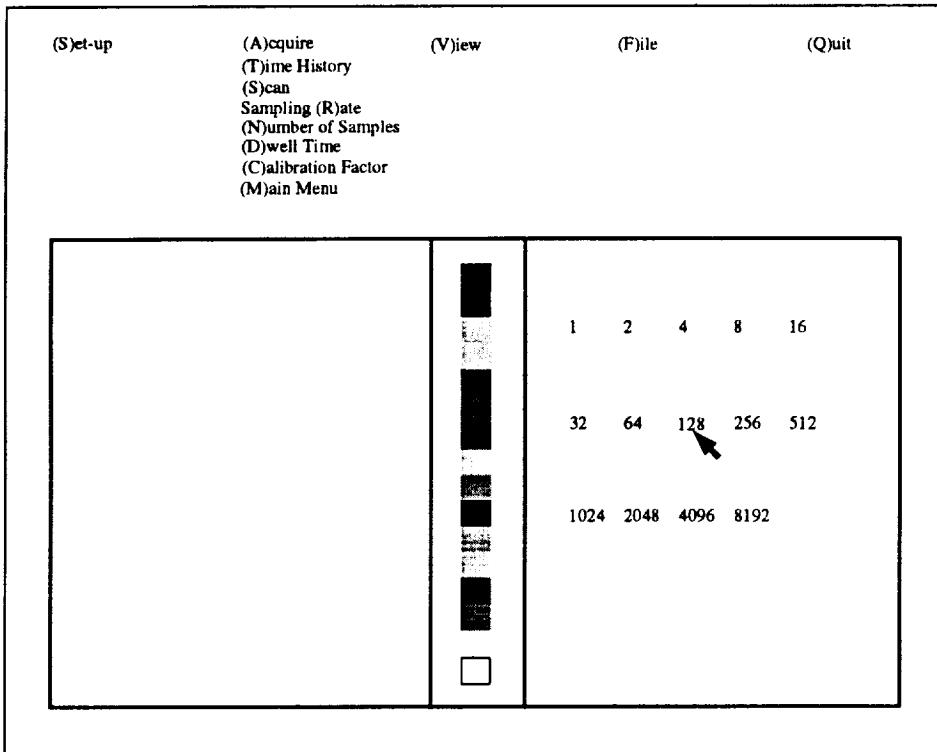
Figure 9: Screen for number of samples options.

(S)et-up   (A)cquire   (V)iew   (F)ile   (Q)uit

(T)ime History
(S)can
Sampling (R)ate
(N)umber of Samples
(D)well Time
(C)alibration Factor
(M)ain Menu

Enter Dwell Time:
(0) 0ms , (1) 5 ms , (2) 7.5 ms -> 2
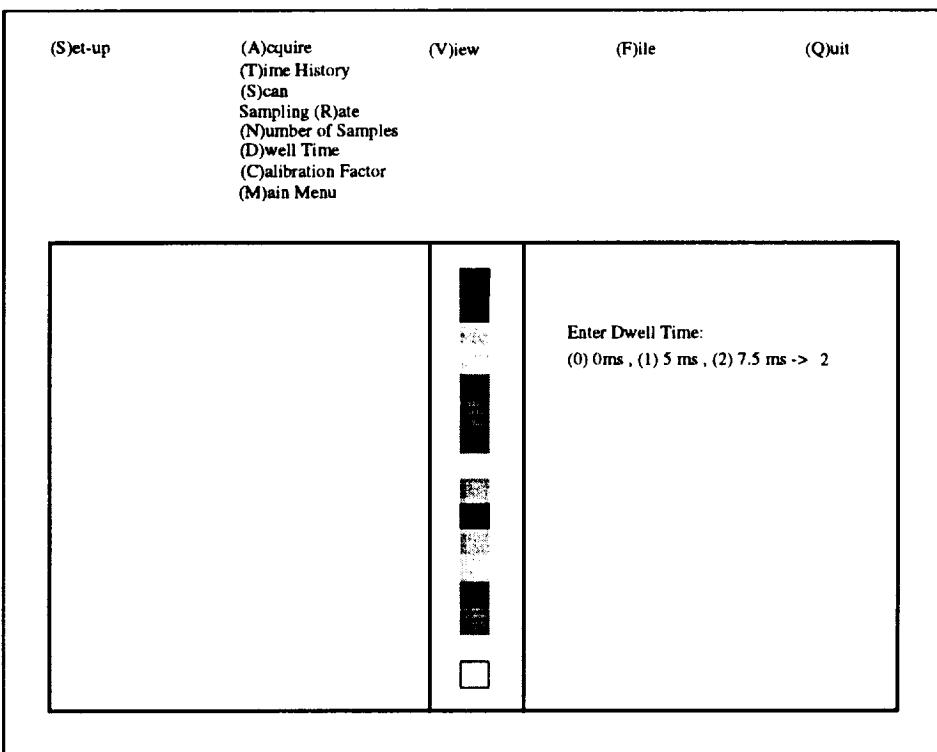
Figure 10: Screen for dwell time options.

(T)ime History
(S)can
Sampling (R)ate
(N)umber of Samples
(D)well Time   (L)ow Range
(C)alibration Factor   (M)edium Range
(M)ain Menu   (H)igh Range
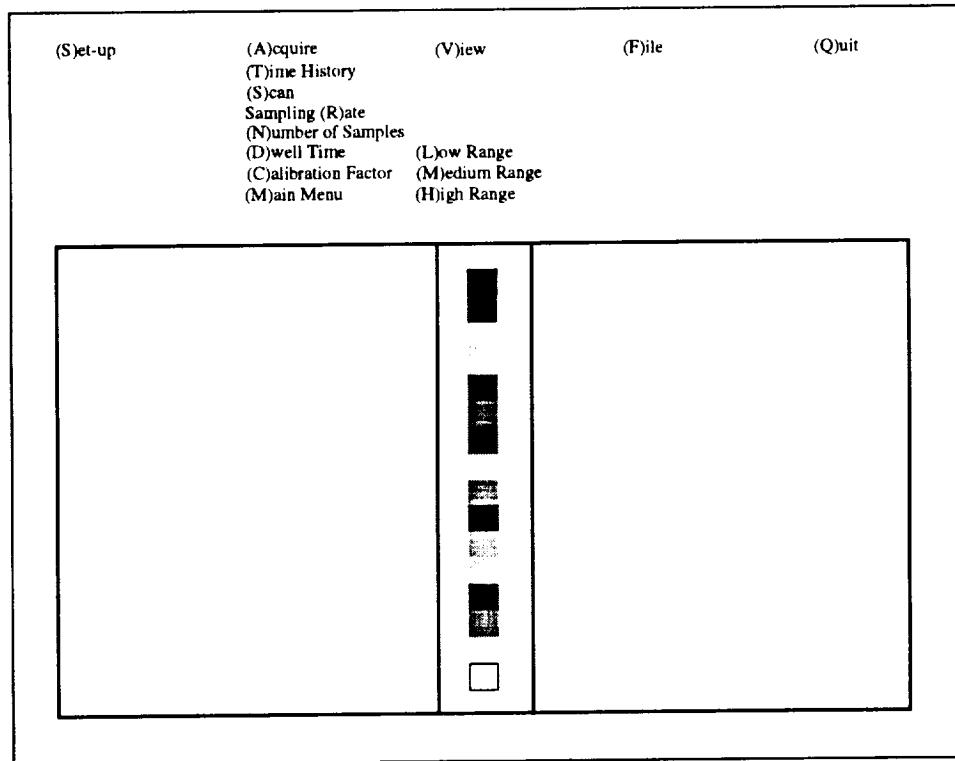
Figure 11: Screen for calibration factor options.

(S)et-up   (A)cquire   (V)iew   (F)ile   (Q)uit
(R)ange
(D)isplay
(Z)oom
(P)robe
(M)ain Menu
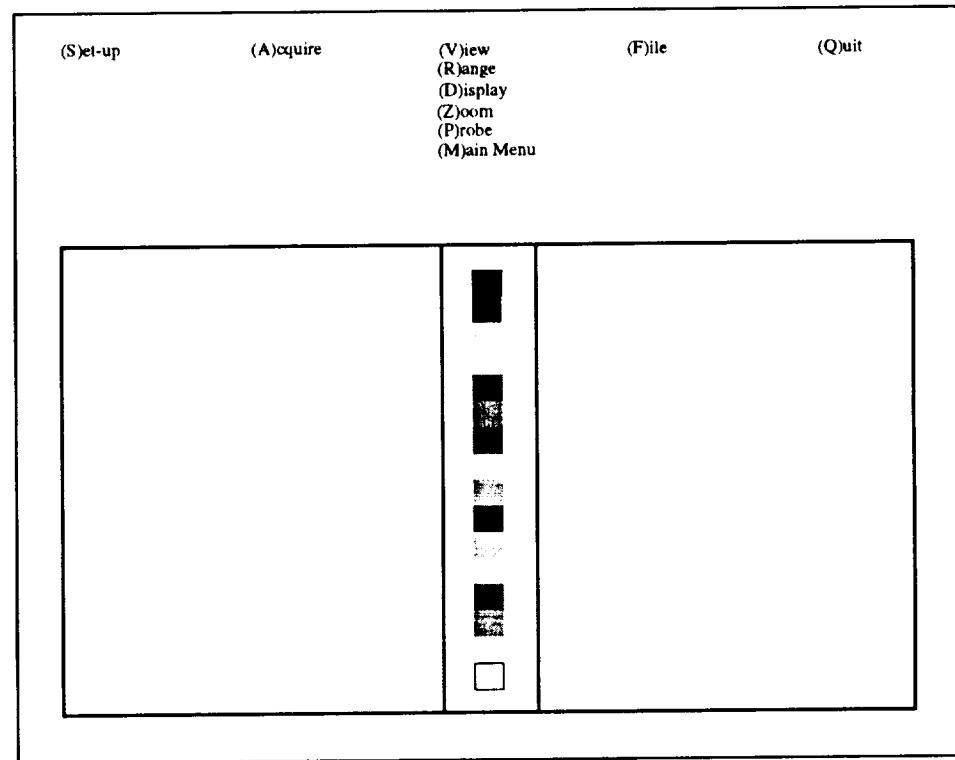
Figure 12: Screen for view menu selection.

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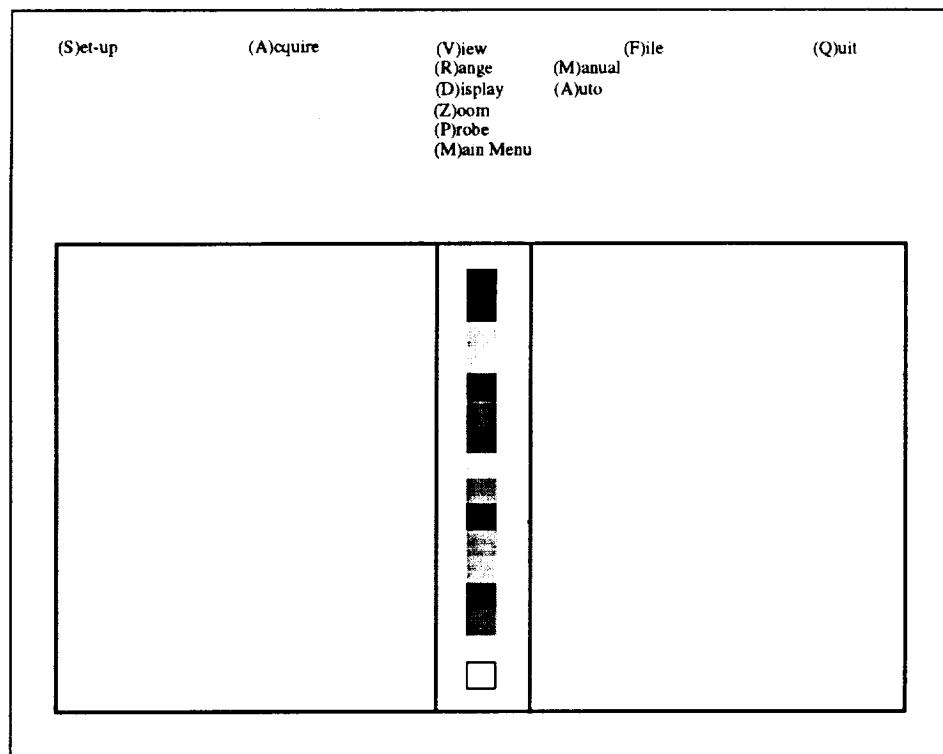
Figure 13: Screen for display range selection.
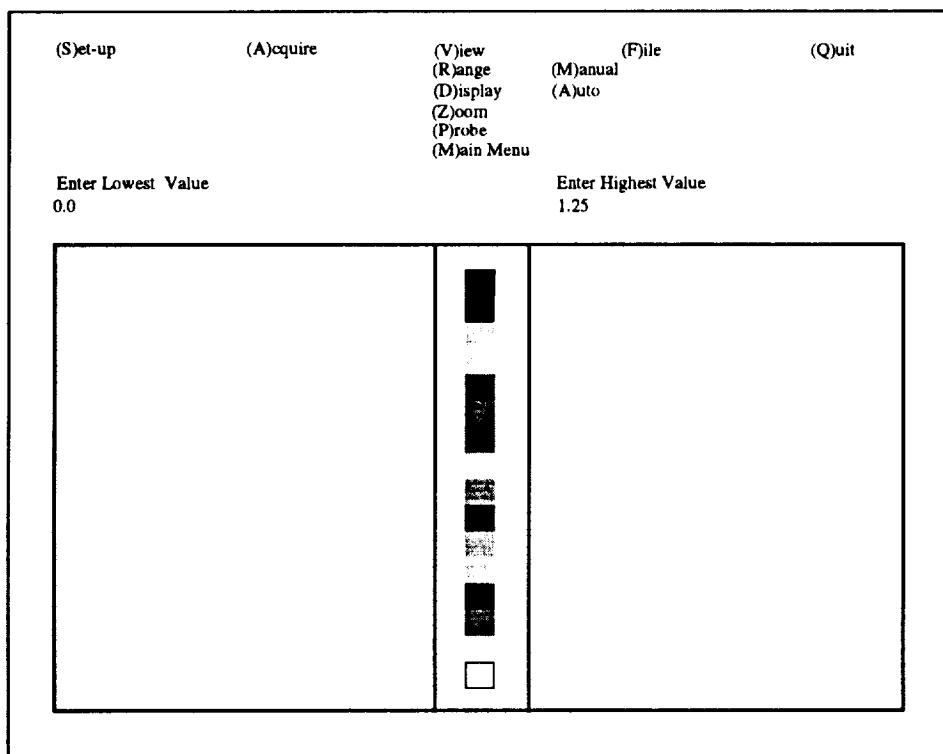

Figure 14: Screen for manual display range selection.

(S)et-up   (A)cquire   (V)iew   (F)ile   (Q)uit
                                      (R)ange   (M)anual
                                      (D)isplay   (A)uto
                                      (Z)oom
                                      (P)robe
                                      (M)ain Menu

Lowest Value   Highest Value
0.0189   1.2467
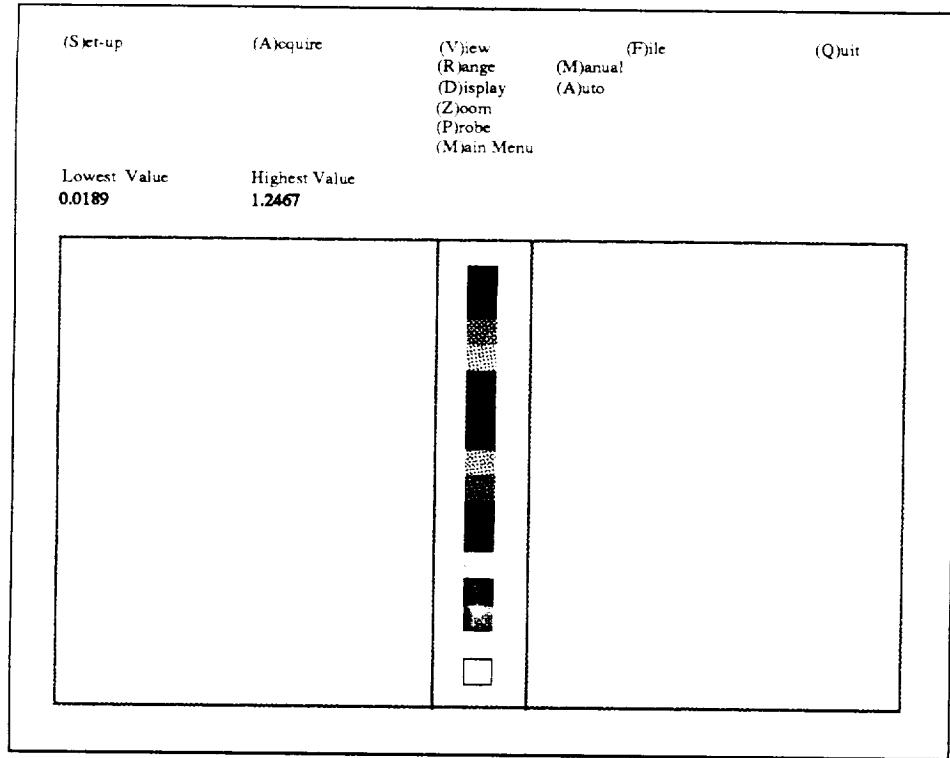
Figure 15: Screen for automatic display range selection.

(S)et-up   (A)cquire   (V)iew   (F)ile   (Q)uit
                                      (R)ange
                                      (D)isplay
                                      (Z)oom
                                      (P)robe
                                      (M)ain Menu
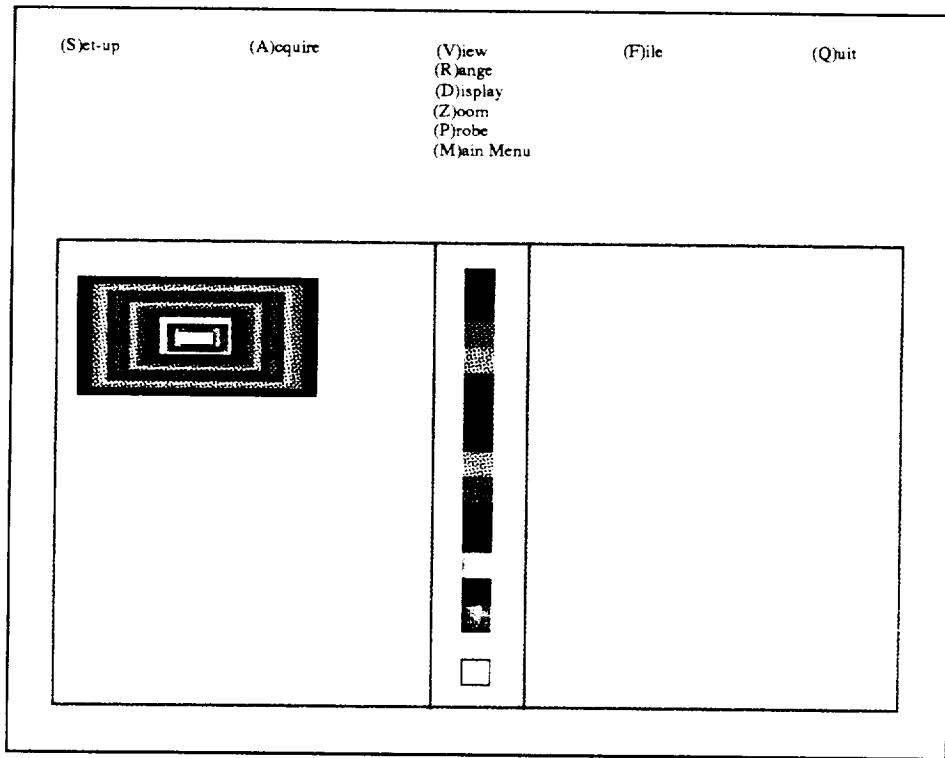
Figure 16: Screen for displayed data.

(R)ange
(D)isplay
(Z)oom
(P)robe
(M)ain Menu
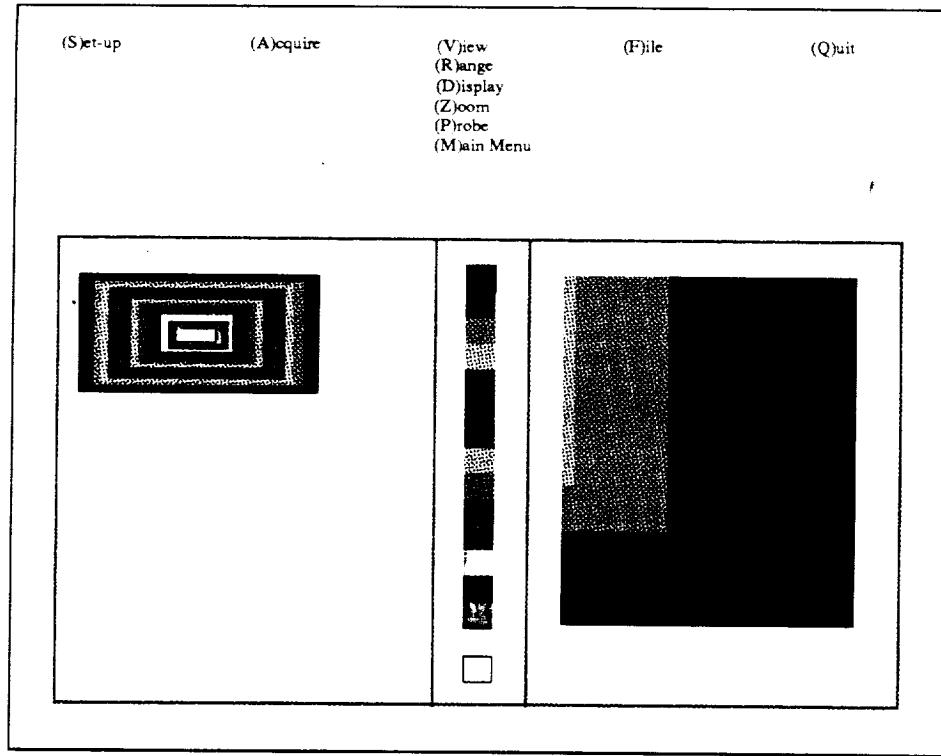
Figure 17: Screen for zoomed data.

(S)ave Data
(R)etrieve Data
Save (C)onfigure File
Retrieve Configure (F)ile
(M)ain Menu
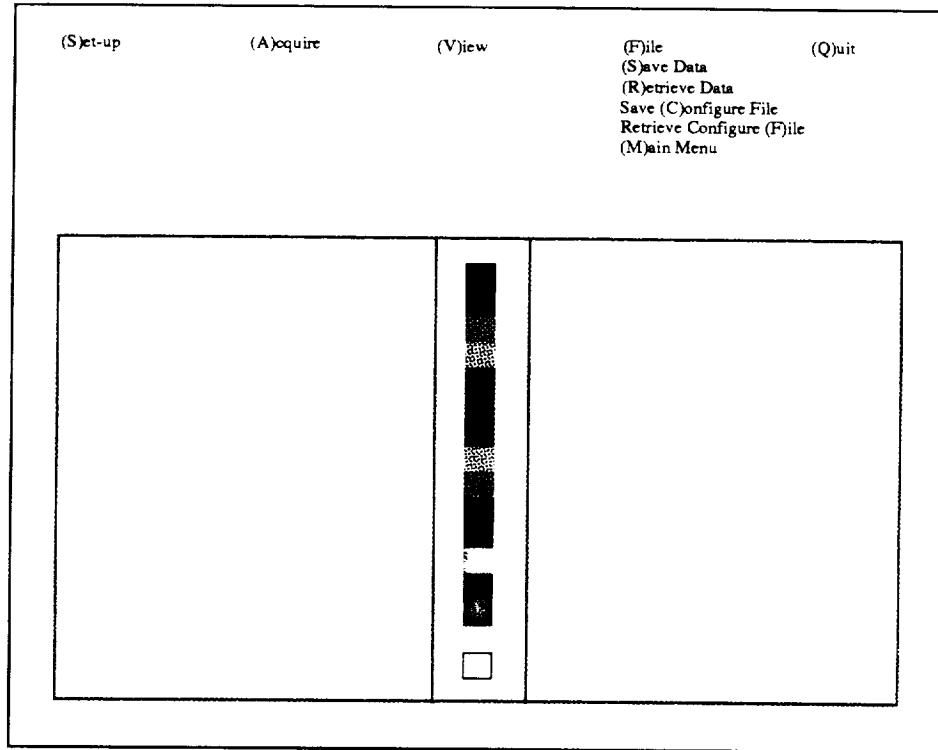
Figure 18: Screen for file menu selection.

Part V Sample Data

Sample data is included on the distribution diskette in the directory SAMPLES. A sample geometry (SAMPLE.GEO), configuration (SAMPLE.CFG), and scan file (SAMPLE.SCN) are included. The sample data was collected from a series of tests on a vibrating stiffened panel [8]. The data was collected over a 135×121 ($x \times y$) scan area using 512 data points sampled at 20 kHz for the computation of the rms value. The data was plotted using Tecplot [7] and is shown in Figure 19.
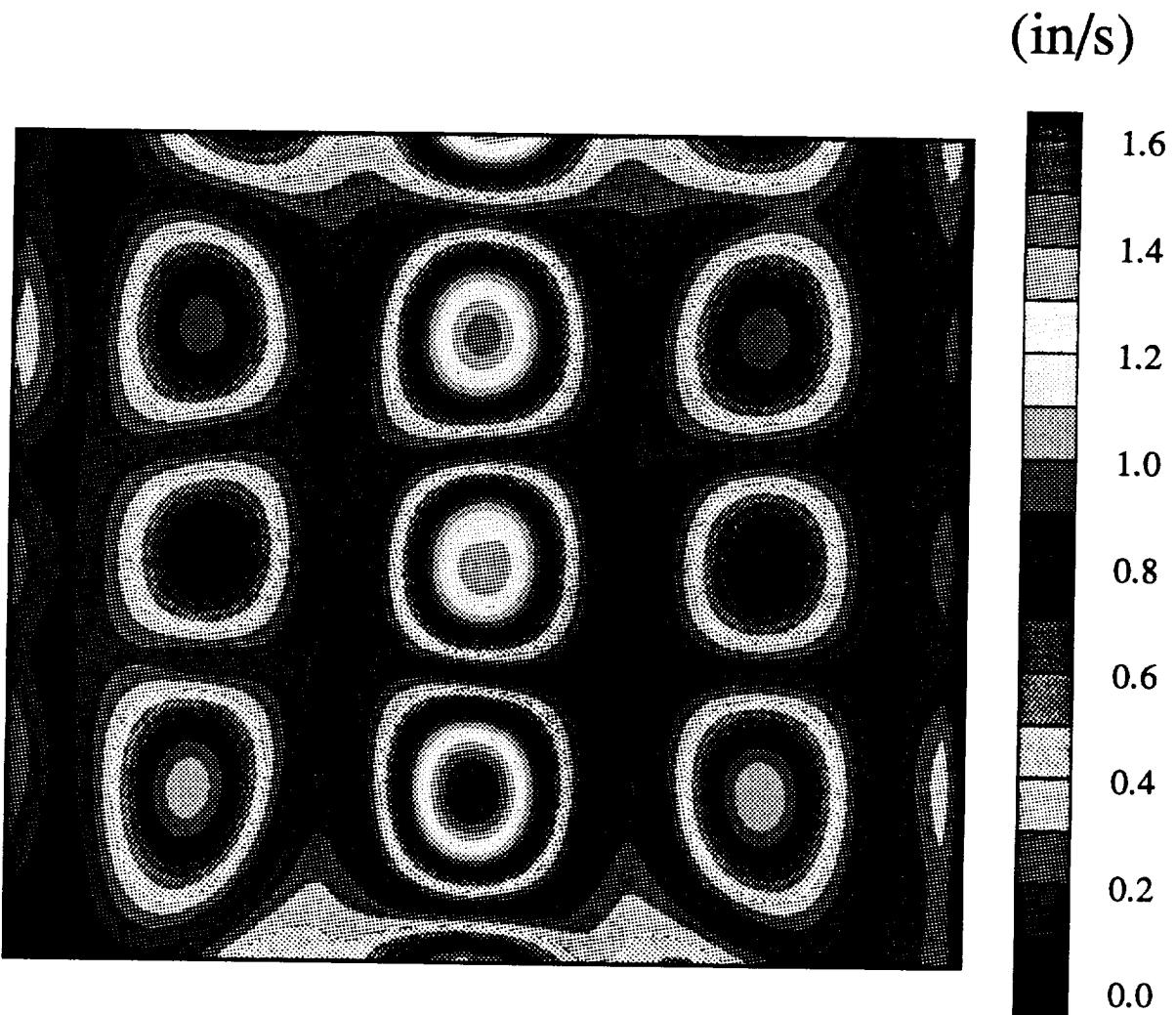
Figure 19: Sample scan data.

Part VI System Programming

Both the PC and SPIRIT-30 DSP software may be modified to provide additional capabilities or to interface with other sensors. The next two sections describe the additional software required for further PC and DSP software development. The functions of each of the source programs are outlined.

PC Programming

The following software is required for additional PC software development:

□ Microsoft C Compiler, version 6.0 or higher
·□ SPIRIT-30 Run Time Library (RTL)
□ Microsoft Mouse Library
□ C language source code for PC

C Compiler

The source code for the PC was written and compiled using the Microsoft C compiler, version 6.0. The C compiler should be installed as per the instructions supplied with the product. The VPI program requires the use of the large memory model, so either LLIBCE.LIB or LLIBC7.LIB should be installed for emulation (E Option) or math co-processor (7 option), respectively.

SPIRIT-30 RTL

The SPIRIT-30 RTL is a set of C-callable functions for board communication, data transfer, configuration, and monitoring of the SPIRIT-30 board. The RTL is available from Sonitech International Inc. (Part No. SP30–ISA-RTL) and should be installed as per the instruction supplied with the product. The VPI program requires the use of the large memory model, so the large memory model of the RTL (S30LTOOL.LIB) must be used.

Mouse Library

The Microsoft mouse library is available as part of the *Microsoft Mouse Programmer's Reference Guide* [9], Microsoft Part No. 000–099–066. The mouse library may be installed anywhere on the hard disk.

C Source Code

The C language source code is available on the distribution diskette in the directory C_PROG. The contents of the C_PROG directory are:

— GLOBAL.H
— MAIN.C
— MENU.C
— GEOMET.C

— GRAPH.C
— SAVE.C
— SCAN.C
— TIME.C
— COMPILE.BAT
— VPI.MAK
— POSTVPI.C

GLOBAL.H   Global include file. Contains all include statements and global variable definitions.

MAIN.C   The following routines are in MAIN.C:

— void main(): initializes SPIRIT-30 board and video

MENU.C   The following routines are in MENU.C:

— void menu(): provides the main menu choices for the program
— void setup(): provides the menu choices for the setup section
— void acquire(): provides the menu choices for the acquisition section
— void samprate(): provides the menu choices for the sample rate section
— void samplenu(): provides the menu choices for the number of samples section
— void calib(): provides the menu choices for the calibration factor section
— void display(): provides the menu choices for the display section
— void specdef(): provides the menu choices for the auto range section
— void specminmax(): provides the menu choices for the manual range section
— void io(): provides the menu choices for the file section
— int chmos(int,int,int,int,int *,char *,int,int,int,int,int,int *): search and check techniques to provide individual menu choices
— void key(int *): provides check to see if <Esc> or right mouse button has been struck
— char mek(char): checks for keyboard hit and returns the value
— char menukey(char): waits for a keyboard hit

GEOMET.C   The following routines are in GEOMET.C:

— void recdef(): defines the rectangular region to scan
— void rectasn(int, int, float, float): assigns x,y positions to scan
— void loadgeo(): loads x,y locations to SPIRIT-30 board and DRAM
— void savegeo(): saves geometry data to a file
— void retrgeo(): retrieves geometry data from a file

GRAPH.C   The following routines are in GRAPH.C:

— void setvid(): sets video to VGA
— void bar(): draws color bar
— void probe(): probes data for x, y, rms values

— void draw(): displays data
— void datasearch(): searches for min, max values of rms
— void zoom(): zooms in on displayed data
— void enlarge(int, int, int, int): manipulates data for zoom
— void box(int, int, int *, int *, int *): picks corners of box for geometry definition
— void zbox(int, int, int *, int *, int *): picks corners of box for zoom definition

SAVE.C The following routines are in SAVE.C:

— void savedata(): saves data in a file
— void retrdata(): retrieves data from a file
— void saveconf(): saves configuration in a file
— void retrconf(): retrieves configuration from a file

SCAN.C The following routines are in SCAN.C:

— void scan(): scan routine
— void getrms(): uploads rms data from SPIRIT-30 board

TIME.C The following routine is in TIME.C:

— void timehist(): obtains time history at a single point

COMPILE.BAT Batch file to compile VPI program using the NMAKE utility.

VPI.MAK VPI.MAK is the "make" file used by COMPILE.BAT. It assumes the following library locations: C:\LIB — the mouse library directory, C:\C60\LIB — the C library directory, and C:\SPIRIT30\LIB — the SPIRIT-30 run time library directory.

POSTVPI.C Post-processing program to convert scan data collected using the VPI program from binary to ascii.

DSP Programming

The following software is required for additional DSP software development:

☐ TMS320C30 Assembler/Linker [10, 11]
☐ EDSP and Debugger (Optional) [12, 13]
☐ TMS320C30 assembly code for SPIRIT-30

TMS320C30 Assembler/Linker

The source code for the SPIRIT-30 board was written and compiled using the Texas Instruments TMS320C30 assembler and linker. The assembler and linker should be installed as per the instructions supplied with the product. This product is available from Sonitech International Inc. (Part No. ASLK30/40–DOS).

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EDSP and Debugger

The EDSP [12] and Debugger[13] are two development aids provided with the SPIRIT-30 board as part of Sonitech International Inc. Part No. SP30–ISA-256. Their use is optional.

TMS320C30 Assembly Code

The TMS320C30 assembly language source code is available on the distribution diskette in the directory S30_PROG. The contents of the S30_PROG directory are:

— BRANCH.ASM
— NOP_30.ASM, NOP_30.CMD
— LDGEO_30.ASM, LDGEO_30.CMD
— SCAN_30.ASM, SCAN_30.CMD
— PROBE_30.ASM, PROBE_30.CMD
— UPRMS_30.ASM, UPRMS_30.CMD
— ASSMLNK.BAT

BRANCH.ASM Initialization code for booting up programs on the SPIRIT-30 board.

NOP_30.ASM, NOP_30.CMD Halts SPIRIT-30 board by looping indefinitely in a no operation loop.

LDGEO_30.ASM, LDGEO_30.CMD Downloads geometry data from PC to DRAM.

SCAN_30.ASM, SCAN_30.CMD Scans geometry stored in DRAM and stores rms value in DRAM.

PROBE_30.ASM, PROBE_30.CMD Probes a single location for time history and rms value.

UPRMS_30.ASM, UPRMS_30.CMD Uploads rms values from DRAM to PC.

ASSMLNK.BAT Batch program to assemble and link TMS320C30 programs.

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13. ABSTRACT *(Maximum 200 words)* The Vibration Pattern Imager (VPI) system was designed to control and acquire data from scanning laser vibrometer sensors. The PC computer based system uses a digital signal processing (DSP) board and an analog I/O board to control the sensor and to process the data. The VPI system was originally developed for use with the Ometron VPI Sensor, but can be readily adapted to any commercially available sensor which provides an analog output signal and requires analog inputs for control of mirror positioning. The sensor itself is not part of the VPI system.

A graphical interface program, which runs on a PC under the MS-DOS operating system, functions in an interactive mode and communicates with the DSP and I/O boards in a user-friendly fashion through the aid of pop-up menus. Two types of data may be acquired with the VPI system: single point or "full field." In the single point mode, time series data is sampled by the A/D converter on the I/O board (at a user-defined sampling rate for a selectable number of samples) and is stored by the PC. The position of the measuring point (adjusted by mirrors in the sensor) is controlled via a mouse input. The mouse input is translated to output voltages by the D/A converter on the I/O board to control the mirror servos. In the "full field" mode, the measurement point is moved over a user-selectable rectangular area. The time series data is sampled by the A/D converter on the I/O board (at a user-defined sampling rate for a selectable number of samples) and converted to a root-mean-square (rms) value by the DSP board. The rms "full field" velocity distribution is then uploaded for display and storage on the PC.

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