DEVELOPMENT OF LABORATORY AUTOMATION SYSTEM FOR THE PERFORMANCE TEST OF AGRICULTURAL MACHINERY

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1. Background

Actually in CPAC (Cerrados Agricultural Research Center) the system used of collect the data of tractor performance is based on load cell transducers, strain meter and galvanometer. All the data is stored on the photo sensytive paper in the galvanometer. The system is mounted on the tractor, and the data printed in the paper is processed by means of planimeter in the laboratory after test is over. Reading the peak data on the photo sensytive paper is difficult that the calculation of average or fraction of the data have some misreadings. It takes a lot of time to read the data on it, so the repetitions of the testing is limited by this processing time.

2. Objective

The objective of this study is to develop a real time data processing system (part of Laboratory Automation System) with a personal computer to minimize the data processing time required in the conventional method using a galvanometer and planimeter. This new method will be applied for the performance test of agricultural machinery in the field.

3. Materials

Instruments used are as follows:

1. Four Channel Magnetic Cassette Tape Data Recorder, Type RTP-50Aby KYOWA LTD. JAPAN.

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2. Digital Storage Oscilloscope with RS232C interface, Type VC-6025 by HITACHI CO. LTD. JAPAN.
3. 1h bit Personal Computer with MS-DOS V 3.3 and Basic, Type 98 note by NEC JAPAN.
4. Data Acquisition Program in Basic, Type "SDAS" by TANIWAKI, FOLLE, FRANZ.

4. System Configuration

The Simple Data Acquisition System (SDAS) is composed of three parts. The first part of SDAS consists of a 4 channel data recorder (RTP-50A by Kyowa Electronics Co. Ltd). Data form the combination of transducer and amplifier are stored in the Phillips standard cassette tape. But the way that the data are stored in the tape is quite different from that of an audio cassette recorder. The signals are frequency-modulated for the stability of the data. Input signals should not exceed +- 5 V and the signal noise ratio should not be less than 42 dB. The recordable frequency should not exceed 2.5 KHz when using a 9.52 cm/sec tape speed, or 1.25 KHz when using a 4.76 cm/sec tape speed. Since the data recorder does not have an erasing head, the user must see to it that the old tape has passed through the magnetic eraser.

The second part of the SDAS consists of a storage oscilloscope (VC6025 by Hitachi Co. Ltd.) used for the conversion of analog data to digital data. The storage oscilloscope is equipped with a 8 bit converter of analog to digital. The precision of the data reaches 256 level steps of acquisition range. Since the conversion speed of the storage oscilloscope exceeds 50 MHz, the frequency band width of the data without aliasing is around 20 MHz. After the data are converted into digital data, they are stored in several frames of memory, the first one being a display memory. SDAS is using only this frame of memory. There is another display memory for channel 2, and 2 acquisition memories. The size of the display memory is 1000 words, corresponding to 1000 bytes. The size of the acquisition memory is 2000 words in roll mode and normal mode or 1000 words in equivalent mode. All the data are stored in these frames of memory and they are transferred into the personal computer.

The third part of SDAS consists of a personal computer and its software. Any kind of personal computer can be used, but in SDAS a PC9801 series personal computer (by NEC) is used. One floppy disk with

1.2 mega byte data capacity and one external (but enclosed in a casing) random access memory used as ram diskette are supplied as external storage device. Capacity of the main memory is 640 Kbytes. Central processing unit of the system is cmos type v30 (it is a LSI object compatible with Intel's 8086 and produced by NEC). Operating system is MSDOS v. 3.3. by Microsoft. Handling program is written in BASIC (N88BASIC by NEC, one of the dialects of Microsoft BASIC). Stored data are transferred and stored in files in order to calculate several parameters. SDAS can calculate only a simple mean of the 1000 data of the display memory. It will be extended for connection to other signal processing softwares.

5. Preparation

If necessary the data recorder of SDAS can be transferred to the proper site to obtain the data. For the testing of a tractor pull bar draft, the instrument should be mounted on the tractor and the data can be obtained from the combination of the load cell which is used to determine the distortion or load by a strain gauge and strain amplifier, i.e. a special amplifier consisting of a modulated power supply and demodulated amplifier.

After all the cables are connected correctly, strain meters are balanced by pushing the automatic balancer switch. If the arrow of the monitor amperemeter appears in the center of the display, it is assumed that the cables are well connected, if not, the cables, connectors, and the transducer itself should be checked. Next the adequate strains for the testing should be estimated. Strain gauge tyupe transducer usually takes a value of 3000 micro distortion at the maximum limit of the measurement. For the load cell, if the maximum measurement value of the transducer is 5000 kgf, and assuming that the value of the pull bar draft is 1500 kgf, and the operation is not difficult, 2000 micro for 2 volt of the calibration voltage is adequate. These are the preparations for the measurement.

6. Operation

6.1. Operation of data recorder

The operation of the data recorder is similar to that of a usual audio tape recorder be except for the adjustment of the zero base, and level of

input. Zero base adjustment is easy, as follows: Select the channel to monitor with the channel selector, and using a small trimming screw driver, turn the trimming volume to adjust the arrow to the center of the monitor meter. The data recorder has 3 steps of input level. If the signal input is very small use the level range 1 V. If the signal input exceeds 2 V, use the range of level 5 V out a 2 V range level can be used for the other steps.

There are two tape speeds, 9.52 cm/sec, and 4.76 cm/sec. If the tape speed is high, the recording time becomes short as the power band width increases.

When this setting is performed properly, first, record the calibration data from the strain amplifier. Three levels of calibration data are necessary as follows: plus minus and zero. During the recording of the data, the microphone should be used for the oral record. After the calibration data are recorded, data of each run can be recorded. At this time some announcement should be recorded. If the field test is over, the data recorder is removed from the testing device and taken back to the laboratory.

6.2. Operation of oscilloscope and SDAS program

The system consists of an oscilloscope and a personal computer. The data in the data recorder are reproduced and transferred into the oscilloscope. BNC connector with a wide frequency and small loss is used for the connection. Two channels can be used at the same time. In the front panel, there are many switches and dials, but the system never breaks. If there is a deadlock, the power should be put off, and a new trial should be made. At first, if the power is put on, some automatic diagnosis program will start to tune it after several minutes. If the operation becomes stable, the left side of the seesaw switch designated as "AUTO" should be pushed in order to increase the sampling interval. For data on traction draft, the sampling interval should exceed 0.1 second. The "FWD" button of the data recorder is then pushed to reproduce the data and some signals will appear on the secreen. If not, the range of voltage of each channel should be checked. The dial labeled "VOLTS/DIV" should be turned clockwise to see the signal. If the signal appears, the switch "STORAGE" located below the screen should be pushed, as it is the toggle switch which must return to the non-storage mode. With this sampling speed and storage mode, the data are flowing into the screen. If the first data fill the screen, the hold switch should be pushed to freeze the data. At the same time, the data recorder should be switched off.

At this point or before touching the oscilloscope, the oscilloscope and personal computer should be connected with an EIA standard RS232C cable. After the connection, the program named "acqdsp.bas" in the file should be run. There comes a message of prompting calibration value. A value in a micro unit should be given. Next prompting plus data of calibration and the signal "Are your ready" appear. At that time, in the screen of the oscilloscope, the plus data of calibration must appear. Next the minus data of calibration appear. In each of these cases, the data should be input into the screen of the oscilloscope from the data recorder following the prompts.

After all the data are processed into the personal computer, the character "n" or "N" should be indicated after the prompt. As a result the calculated data will be printed out. Since all the data are stored in the files they can be open and read for processing to obtain more parameters.

7. Future developments

The system will be extended to acquire all the parameters of tractor testing such as fuel consumption and ground speed, by the combination of the tractor-mounted microcomputer, controlled data acquisition system and stationary data processing system. This data acquisition and processing system will be usefull for the computer simulating farm production systems. It is anticipated that it will be possible to develop a consultation system for the farmers.