Application of CAM in Online Measurement of Mechanical Parameters

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Abstract

Online Measurement of mechanical parameters by using CAM (Computer Aided Measurement) is a new advanced technique in the field of measurement. Taking special measurement software DASYLab as an example, this paper describes the basic principles and unique advantages of this technique. The application of CAM is explained through an example of measurements of temperature, flow rate and pressure.

Keywords: CAM, online measurement, virtual instrument,

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1. Introduction

Online measurement of mechanical parameters is often used in process control but also applicable in laboratories or other technical applications. Online measurement of mechanical parameters is now and especially in future an essential development field for measurement applications. Only through online measurement we can get the real-time signals and can control the process by feedback system. With the development of the computer technology, the research of online measurement by using computer is developing continuously. CAM (Computer Aided Measurement) represents a great leap in the online measurement. It has many advantages, which the traditional methods do not have. Only with sensors, A/D converter, software and PC we are able to define many different measurement systems in which the software is the main part.
This paper introduces a method of using CAM in online measurement of mechanical parameters. By example the application of CAM in online measurement is described.

2. A method of CAM using DASYLab as a major part

2.1 DASYLab

Software DASYLab (Data Acquisition System Laboratory, Germany) is a data acquisition, process control and analysis system, which has full advantages of the features and the graphical interface provided by Microsoft Windows. Using DASYLab, a measuring and process control, or simulation task can be set up directly on the screen by selecting and connecting instrument modules that can then be freely arranged according to the purposes of measurement.

2.2 Modules of DASYLab

The instrument modules include most measurement instruments such as input/output module, trigger functions module, mathematics module, statistics module, signal analysis module, control module, display module, files module, data reduction module, special modules, network module and optional modules.

2.3 Functions of some modules

Among the module functions provided are A/D and D/A converters, pre/post and start/stop triggers, digital I/O, mathematical functions from fundamental arithmetic to integral and differential calculus, statistics, digital filters of several types, frequency analysis including various evaluation windows, signal generators for simulation purposes, scopes for the graphic display of results, logical connectors like AND,OR, NOR, etc., counters, a chart recorder, file I/O, timer, digital display, bar graph, analog meter and more. It is no longer necessary to find the way through lengthy and rigid menu structures. Even highly specialized tasks also can be solved immediately on the screen, interactively and without difficulty. Using the modules provided by DASYLab, we can set up many system- or measurement functions such as waveform generator, transfer function calculation, calibration, data reduction, measuring duration of high/low periods, approximation of square waves, mark samples in a signal, function of combi-trigger, function of cut-out module, function of database and so on. In Fig.1 is the system of power calculation and in Fig.2 is the system of calculation of pulse distances shown as examples for a lot of possibilities with assistance by the software.

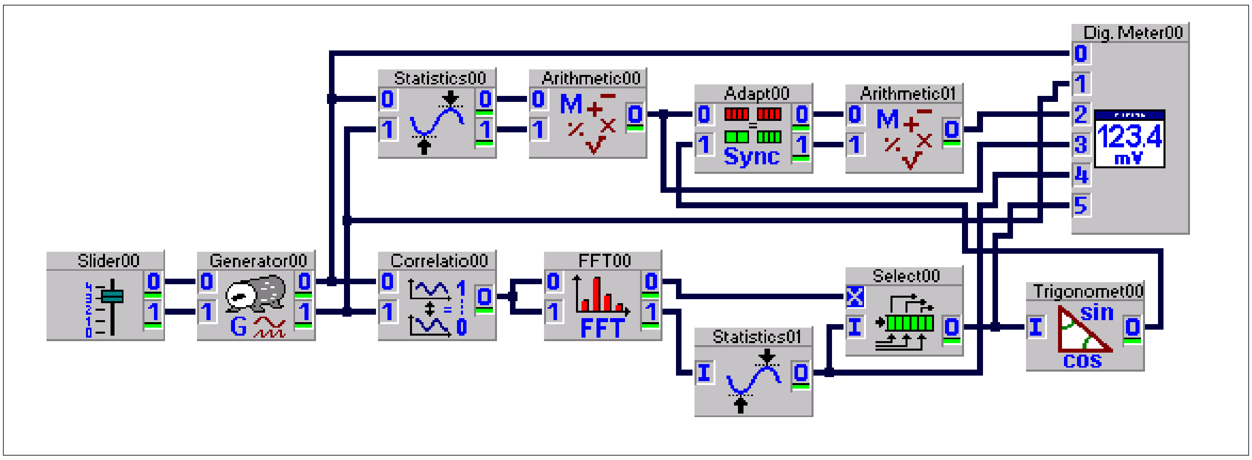

Fig.1 Power calculation

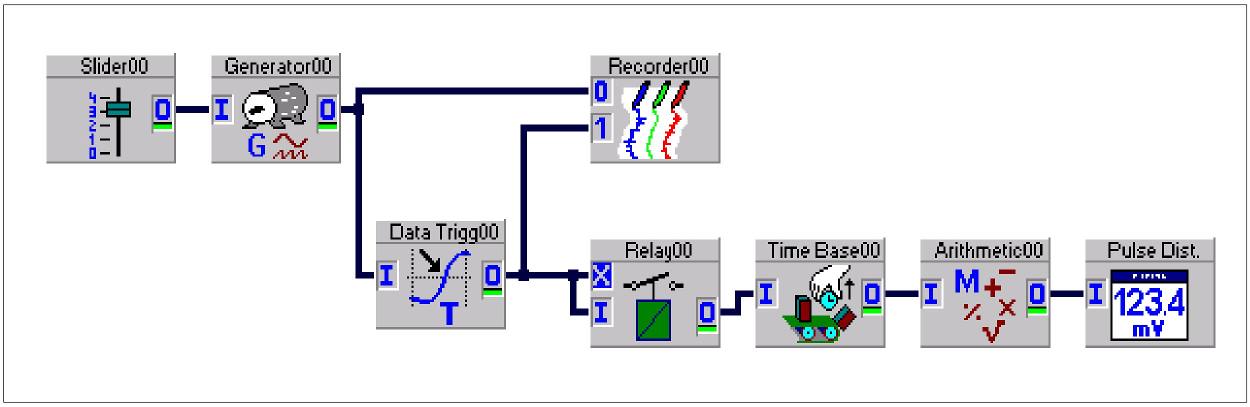

Fig.2 Calculation of pulse distances

2.4 Operation principle

The system of measurement consists of sensors, A/D converter, software DASYLab and a PC. The analog signals from sensors are put into the panels, then the analog signals are changed into digital signals by an A/D converter and are afterwards handled with DASYLab. With the assistance of DASYLab, the measurement system is set up by selecting and connecting the required modules to form virtual instruments needed. Then the measurement can be carry on with the virtual instruments. The acquired data can be processed by different mathematical methods and analyzed both in the fields of time and frequency. The results can be displayed graphically or numerically at the same time and also can be saved on hard disk for further use.

3. Example of application

3.1 The purpose of the experiment

This experiment is carried out to measure online the temperature, flow rate and pressure of a refrigerant plant. Through measuring the temperature, flow rate and pressure in different places of the refrigerating machine the cyclic process can be described. The circuit diagram and pattern of the refrigerant plant is shown in Fig.3. Six essential points are selected for the description of the real cooling process. The description of the cyclic process in the system is shown in the logarithm p/h-diagram of the refrige-r-ant in Fig.4.

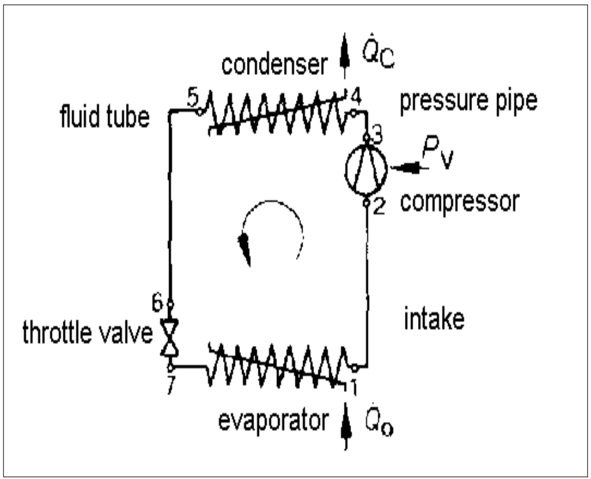

Fig. 3 The circuit diagram

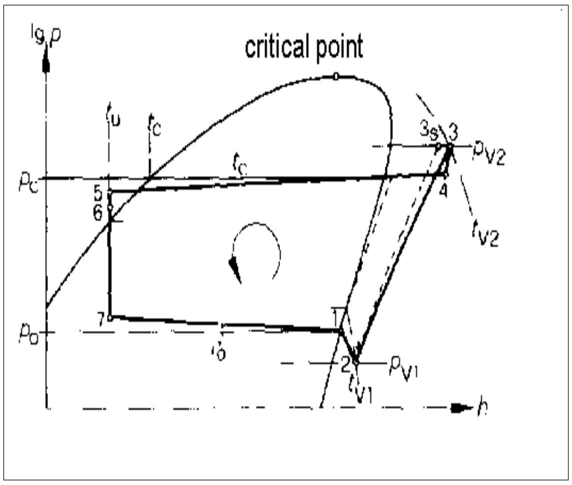

Fig. 4 Lg p/h-diagram of the refrigerant

The described real refrigerating machine consists of the following components: compressor, condenser, refrigerant collecting tank, filter, sediment bowl, gear wheel, safety switch, thermostatic expansion valve and evaporator. The structure system pattern of the refrigerant plant with inserted measuring points is shown in Fig.5. There are 13 sensors are used to pick up the real-time signals, 6 are used to measure the pressure, 6 are used to measure the temperature and the last one is used to measure the flow rate.

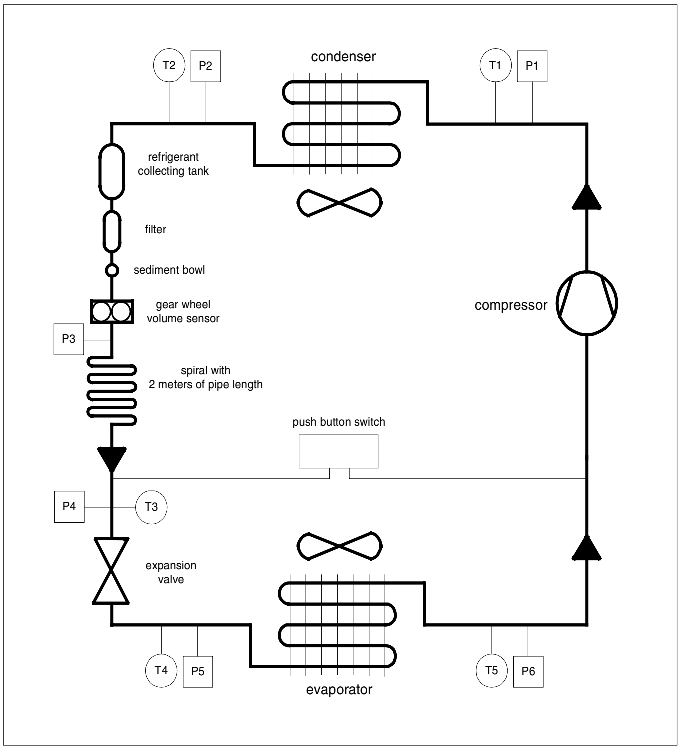

Fig. 5 System pattern of the refrigerant with inserted measuring points

3.2 Design of the measurement system

The measurement system is made up of 13 sensors, 2 panels, A/D converter (DynaRes), the software DASYLab and a high performance computer. Using DASYLab, 11 virtual components are made from instrument modules and the computer. (see Fig.6) The functions of 11 virtual "instruments" are as follows. Among them 4 virtual digital meters are used for display the data of flow rate, voltage and ampere, pressure, and temperature upon the time (see Fig.7), 3 chart recorders are used for display the curves of pressure, flow rate and temperature (see Fig.7). The scaling module is used to perform linear scaling for the 6 pressure signals. The arithmetic module is used to perform multiplication calculation. The filter is a lowpass filter used to cut off 0.05Hz frequency component from the flow rate signal. The data module is used to write the real-time measurement results to the hard disk.

available case this takes place over an air-cooled condenser, which delivers its warmth to the environment. In the evaporator liquid refrigerant is injected on low temperature level. When flowing through the evaporator it is changed from liquid into the gaseous status again. The thermostatic expansion valve regulates the injection of the refrigerant into the evaporator. It ensures that the evaporator always can get enough refrigerant. The temperature sensor of the regulation valve is inside the evaporator (not shown in Fig.5) measuring the temperature and controlling the on or off switch of the compressor.
The results of measurement can be displayed in both combined digital meters or in chart recorder (see Fig.7). The real-time data can be received from the digital meters and from the graphs the periods of the signals can be found as well as the maximum and minimum values and so on.
Through the temperature chart the different characters of the temperature sensors can be compared. Sensors T1 to T5 are thermoresistance sensors (Pt100), their range is –200 ^{0}C to 115^{0}C, resotion is 0.005^{0}C and the accuracy is 0.8^{0}C. T6 is a

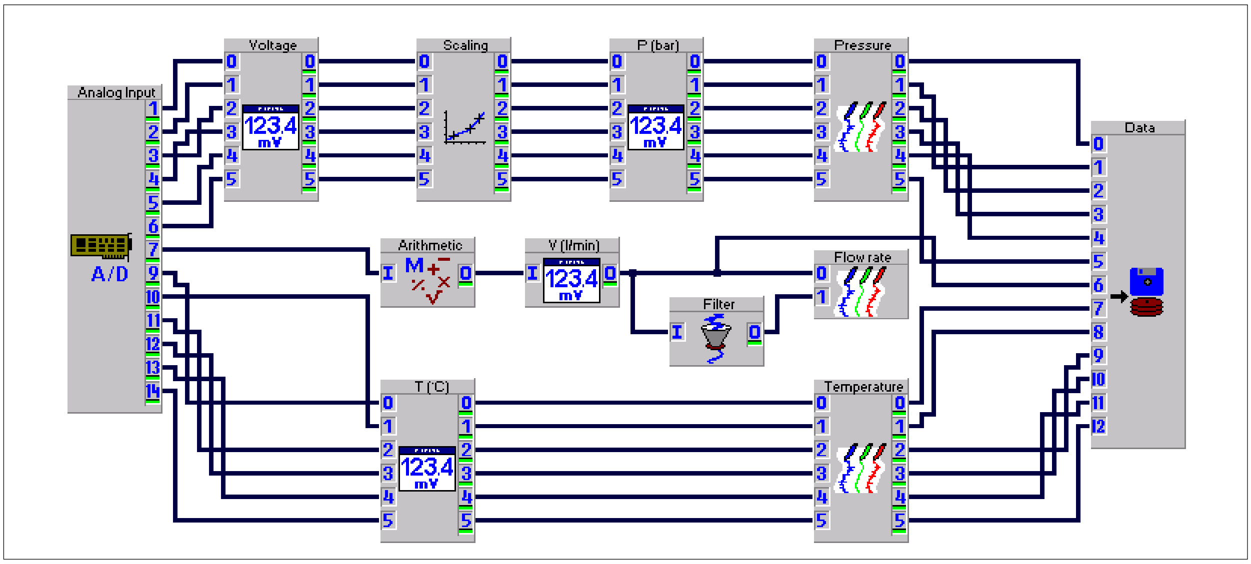

Fig. 6 Block diagram of the measurement system

3.3 The process of the experiment

When switch on power, fluid flows in counter clockwise as shown in Fig.5. In the compressor the vaporous refrigerant is compressed from the level of low pressure to a higher pressure, so the temperature is changed from low to high level. In the condenser the cooling capacity from the evaporator and the energy from the compress taken up is dissipated and the refrigerant with vaporous state changed into liquid state after the condenser. In the

thermocouple inside the cooling room, which is not shown in Fig.5. Its range is from -50^{0}C to 1260^{0}C, the resolution is 0.02^{0}C and accuracy is ±0.7^{0}C. By the flow rate chart the results from with or without filter can be compared. The red curve is with filter that cuts off the 0.05Hz frequency component so the curve is smoother than the blue one. If there are some unusual changes in the curve, the multi-graph display on the screen at the same time will be helpful continuously. CAM will be not only used for measurement but also for combination with control, and will promote the development of standardization, multiple functions and intellectualization.

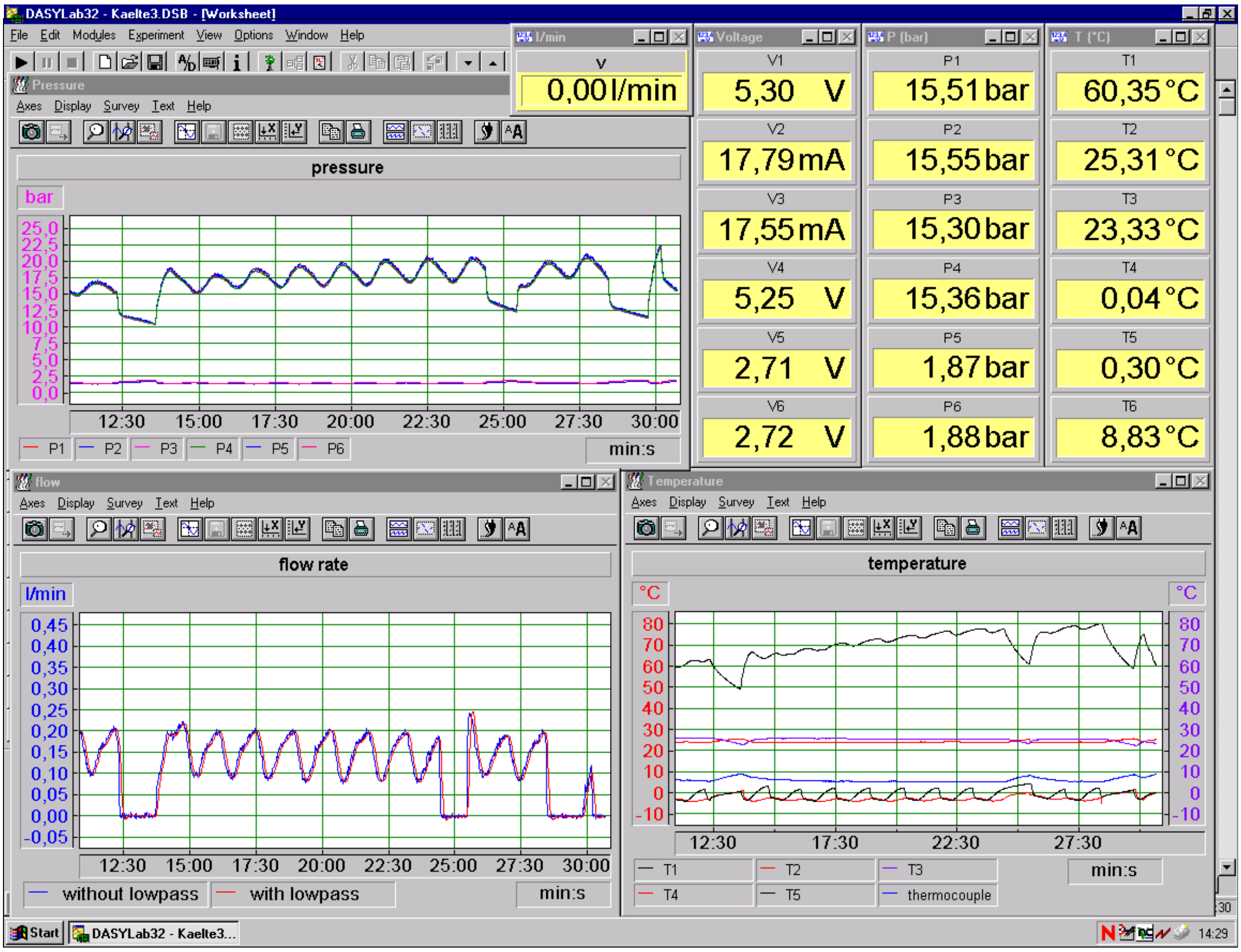

Fig. 7 Some results of the experiment

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