AN ORDER TRACKING ANALYSIS SYSTEM USING LABVIEW BASED ON THE PCI CARD 7030/6040E[*)]

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Abstract. The given paper presents the realization of an order tracking analysis in real-time using National Instruments hardware PCI 7030/6040E. This algorithm was implemented with LabView environment in order to achieve visualization in real time. The details of whole system are shown, ready to practical application.

1. Introduction

The digital order tracking method that displays the resulting frequency spectrum components as stationary lines versus orders (multiples of the shaft rotation rate), instead of frequency [1]. This method eliminates the needs and limitations of tracking lowpass anti-aliasing filters by replacing their functionality with equivalent digital filters and external ratio synthesizers. The registration of experimental data on measuring channels is executed with constant sampling frequency during the several object revolutions, and then the miss of a part of the information can be made, if the analyser processor has no time to the previous data processing in real-time [2,3]. It permits to conduct researches of object with large speeds of rotation. Besides the measurement of only pair of next object revolutions, instead of three ones is required in another approaches. In the given model constant angular acceleration of object on two next complete revolutions is supposed [3]. The PCI7030/6040E card in the given approach can be used to:

1) collect measured data at some fixed rate, digital filtering of the signals using multirate filters;
2) measure and store the arrival times of each synchronizing tachometer pulse simultaneously (it is important to measure the arrival time of each tachometer pulse very accurately to reduce the effects of time jitter);
3) calculate the new digital resampling time points on the base of different rotation models and to store them;
4) interpolate the stored measurement data in some optimum manner to obtain new samples at the desired time points;
5) compute the spectrum in the order domain.

2. Hardware realization

Physical realization of order tracking analysis model was created and tested on Personal Computer with National Instruments hardware PCI-7030/6040E (*fig.1.*). The 7030/6040E line of data acquisition boards from the RT Series family provides real-time, deterministic, and reliable I/O for applications. RT Series boards have an independent 486/133 MHz processor and 8 MB of memory capable of running embedded LabVIEW Real-Time applications, 16 analog inputs with 12-bit resolution allows up to 250kS/s sample rate, two 12-bit analog inputs, 8 digital I/O lines, two 24-bit counters. A LabVIEW Real-Time application running on the RT Series board continues to run even if the host computer has to reboot.

Digital order analyser consists of:

- Accelerator (Introl Electronic PFI 60) and Tachometer (PCB (M) 352C68) connected directly to analog inputs of 6040E device
- National Instruments PCI 7030/6050E
- Personal Computer PIII 450MHz with National Instruments LabView 5.1 environment

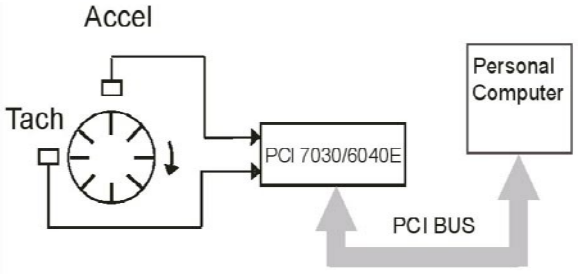


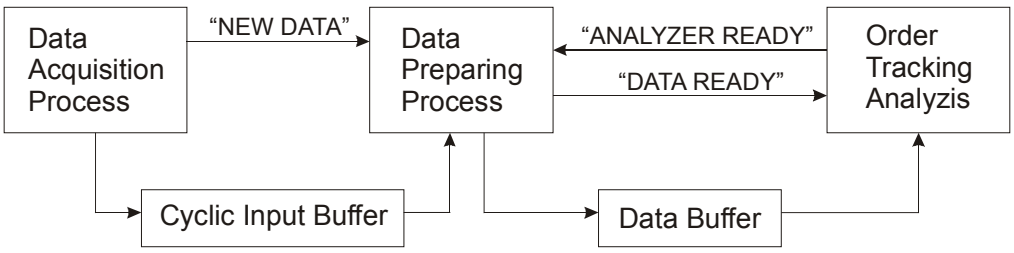
fig. 1. Digital order tracking analyzer

3. Processing of input signals

Proposed application based on National Instruments (hardware and software) consists three processes which are communicating using notifications. First process is responsible for data acquisition from two channels: accelerator and tachometer. It sends “NEW DATA” notification to process responsible for preparing data for analyzing. It collects 1024 samples of input signal every time. Data analyzing process

[*)] This work supported under the grand S/II/02/01

prepares data in second buffer and sends “DATA READY” signal to main process. It sends to data buffer samples from two rotations which is needed in processing. Main process takes samples from data buffer and performs order tracking spectrum analysis. After finished computations main process sends signal “ANALYZER READY” to second process and waits for “DATA READY” signal.



4. Experimental results

The results of experiments with assynchronous power engine during start and after acceleration to it’s nominal speed coming from standard load are shown on figures bellow.

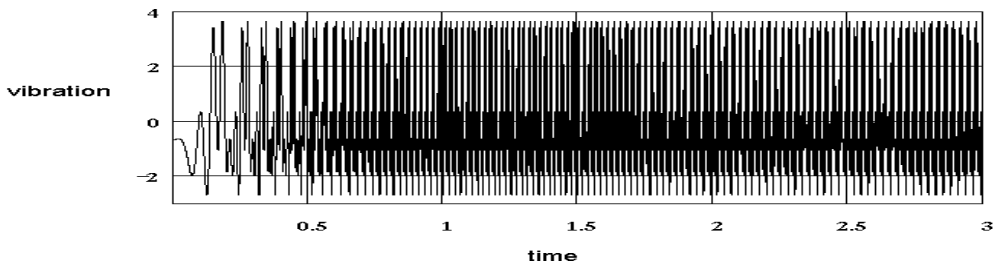


fig.2. Vibration signal asynchronous power engine

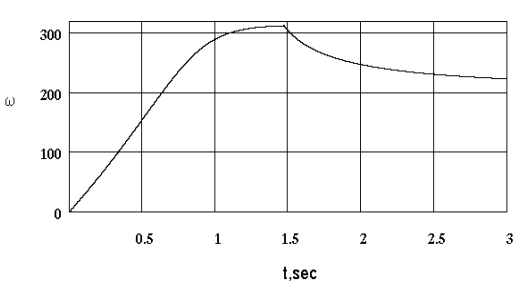


fig.3. Dependence of rotation speed on time

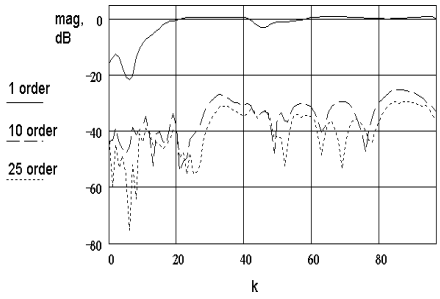


fig.4. Dependence of amplitude of 1,10,25 orders on rotation number

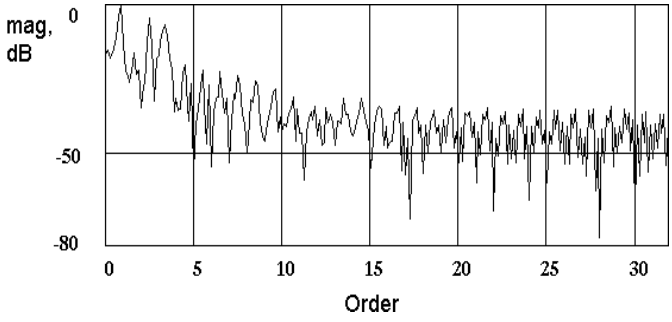


fig.5. Spectrum in order domain

As show modelling results the developed method provides stability of amplitude in analyzing signals with unstable frequencies.

5. Technical data

Proposed model of order tracking spectrum analyzer has dynamic range of the reproduced signal at **70dB**. Maximum sampling frequency of input signal is **125 kHz**, but in cases when DSP card can not perform computations tied to coming from measure devices data, the model allows to omit revolutions of rotating object. Range of observed orders was set from 0 to 12 order. In order to process data in real-time multilevel decimation algorithm is employed, which allows to reduce computational complexity. Proposed application can process data in real-time when speed of rotating object is maximum **300RPM** when computing **128 points**. If rotating speed is greater system omits revolutions which cannot be processed.

6. Conclusion

LabView environment is an industry standard. Using this environment to performing spectral order tracking analysis allows diagnose of the technical state rotating objects at low cost because proposed spectral order tracking analyser can be easy integrated with existing hardware and software. System proposed in this paper can be easily extended with expert system which allow analysing defect of rotating devices during starting and braking without bringing in stable work state.

References

1. Potter R.: A new order tracking method for rotating machinary. Sound and Vibration, September 1990, pp. 30-34.
2. Petrovsky A., Stankevich A., Balunowski J. The order tracking front-end algorithms in the rotating machine monitoring systems based on the new digital low order tracking // Proc. of the 6th International congress “On sound and vibration”, ICSV’99, 5-8 July 1999, Copenhagen, Denmark. – pp.2985-2992
3. A.Petrovsky, A.Stankevich, M.Kachinsky, J.Balunowski. Full-programmable DSP processor based on the TMS320C50 for real-time order tracking spectral analysis // Proc. of the 10th Intern. Symp. on Development in digital measuring instrumentation and 3rd Workshop on ADC Modelling and Testing, ISDDMI, IMEKO TC-4, vol.II, Sep. 17-18, 1998, Naples, Italy. - pp.717-722.