DEVELOPMENT OF DEVICE AND SOFTWARE COMPLEX FOR ACOUSTIC DIAGNOSIS OF PROCESSES OCCURRING IN THE SUPRECRITICAL STATE OF FLUID AND MAGNETIC SYSTEM MONITORING

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There is a problem of studying the processes that occur during the transition of the liquid to the supercritical state and in the process of studying and conducting experiments. There is also a problem of controlling the operation of the electromagnetic system. Since optical, mechanical, electronic, and other control methods are complicated by the conditions (ultra-high pressure, high temperature, a part that requires monitoring is inside a sealed irradiated metal system), the acoustic research method was chosen.

The client-server architecture was chosen to perform the tasks (Fig. 1). Based on the existing material and technical resources necessary to develop applications that will be compatible with Windows 7, which has exhausted the term of service and not overly CPU load.

1) Spectrum! TCP Server (Fig. 2): The adapted TCP server, which takes up 3.7 MB of disk space, has the ability to minimize into a tray so as not to take up too much space in the work area. Designed to obtain data from the microcontroller module and distribute them to customers. The data update period is 1 second since the sample length for spectrum construction is 32768 values, which with a sampling frequency of 32768 Hz is a given time interval. With active data exchange with clients, the server requires a data channel calculated at an average of 600 KB / s per client.

2) Spectrum! (Fig.3): Client application designed to record data, visualize current data. Data is recorded in CSV format for easier processing and compatibility with other applications. Data update period 1 second. Graph sizes are adapted to any size and monitor resolution. The schedule is also easily scalable in any user-friendly area, there is a possibility to select the recording period and an instant recording button for urgent recording in abnormal situations. The application receives 32768 records every second in the range from 0 to 4096, which corresponds to the amplitude obtained by the acoustic module. Next, according to the FFT algorithm, we obtain a spectrum that allows us to estimate the spectral picture of the existing signal from 15 to 16384 Hz (according to the minimum sensitivity threshold of the acoustic module and the Nyquist frequency). For the convenience of data analysis, the obtained data set is normalized by the largest value:

3) Spectrum! ReMember (Fig. 4): The application is designed to visualize, convert and process already saved data.

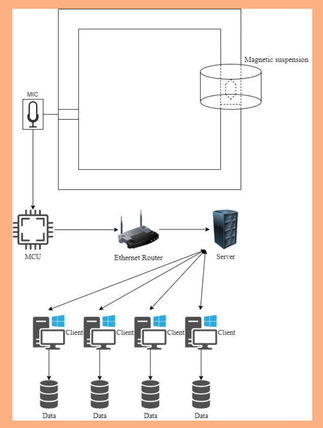

Figure 1. Client-server architecture

Figure 2. Spectrum! TCP Server

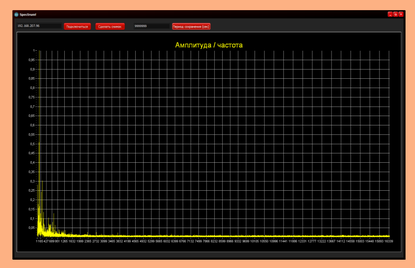

Figure 3. Spectrum!

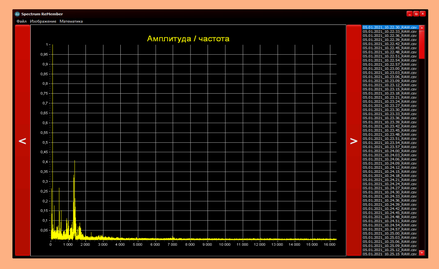

Figure 4. Spectrum! ReMember

Some results acquired during measurements:

During the operation of the application, the following data was received:

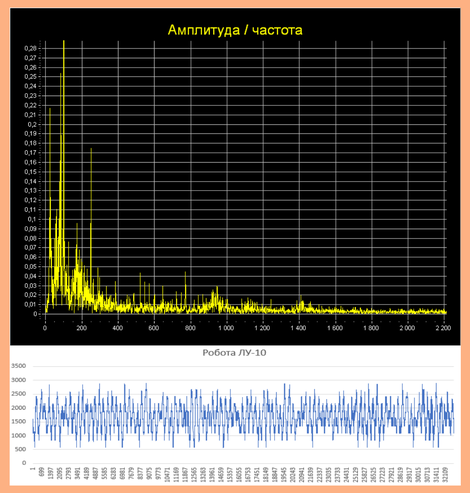

Figure 8. Acoustic sample of LU-10 usual sound

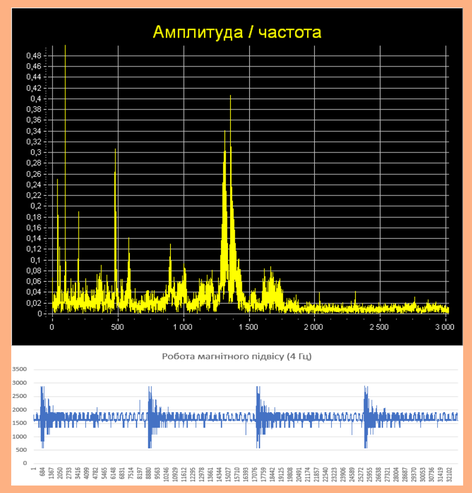

Figure 9. Acoustic sample of magnetic suspension operating sound (4 Hz)

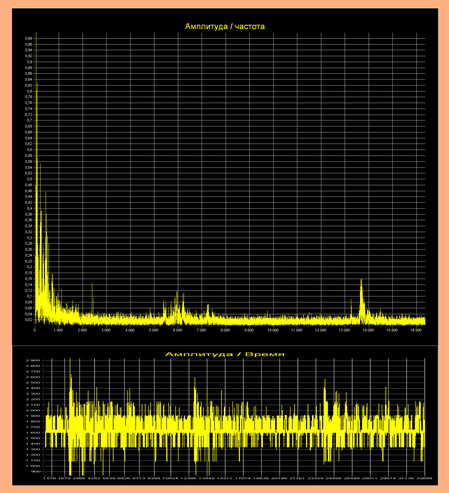

Figure 10. Acoustic sample of magnetic suspension operating sound during experiment

Conclusions:

The developed device and the set of application are currently recording the experimental data for future analysis.

A device has been developed that meets the requirements. It contains 3 modules:
1) Acoustic module MAX9814:

Figure 5. MAX9814 module
This module is responsible for converting acoustic waves into electromagnetic and has the following characteristics:
• Supply voltage: 2.7 V - 5.5 V at a current of 3 mA
• Output: 2Vpp at an offset of 1.25V
• Frequency response: 20 Hz - 20 kHz
• Programmable attack and decline ratio
• Temperature range -40 ° C .. + 85 ° C

2) Microcontroller module STM32F4-Discovery:

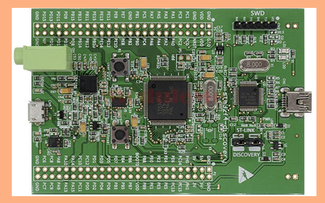

Figure 6. STM32F4-Discovery module
This module is responsible for receiving an analog signal, converting it to digital, accumulating data and transmitting it to the server application via Ethernet. The maximum clock frequency is 168 MHz, the ADC polling frequency is 32768 Hz. Supply voltage 5 V at a current of 300 mA.

3) Ethernet DP83848 adapter module:

Figure 7. Module DP83848
This module is designed for communication of the microcontroller module with the Ethernet network, has the following characteristics:
• Network support: 10 / 100Mbps
• Standard: 802.3u MII / RMII
• Supply voltage: 3.3V
• Power consumption: <270 mW