4 Conclusion

It is indicated from above analysis, owing to Hopf bifurcation phenomenon, the dynamic response of the studied system behaves singularity near the critical point, even if its operating parameter is changed, the characteristic of subcritical bifurcation is unchangeable. It also indicated that, under bigger load and quick excitation, the critical value of amplifying multiple has got smaller, so LFO with increasing amplitude tends to occur under little disturbance, and the subcritical bifurcation will worsen it.

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A/D Converter with Bluetooth Wireless Network in Data Acquisition

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Abstract: In some practice, the data sampling device is moving, so connect the sampling device to computer by ware is not convenience. This article has developed a Bluetooth-based wireless communications, mobile data acquisition and processing system to make up for general data acquisition. In particularly，a small light Bluetooth wireless A/D module as a collection of hardware is used. In this paper, the data collected is in real-time display and recorded, we develop a management system for data analysis and the data is very easy to future processing by various programming languages. Take the advantage of the function of two-direction communication that Bluetooth has, the system can set the A/D sampling rate and quantification bits in the microcomputer easily. It is a convenient and practical A / D acquisition system and you could achieve two-way signals and multi-channel signal acquisition.

Keywords: A/D Sampling, Bluetooth, Data Acquisition

1 Introduction

With the development of computer technology, the popularity of digital devices are increasingly and beginning to replace analog equipment. The A/D conversion and data acquisition has become the basic functions of digital devices. In real life, we often encounter in a signal that be collected in a moving object and the signal acquisition time is too long or no access. Such being the case, this article uses the Bluetooth short-range wireless transmission technology and A/D sampling module. Throughout the acquisition module is only a few grams of weight and it can be easily installed near by the analog signal source to be collected. Using the Two-way communication function of Bluetooth, not only could we achieve the data that was collected upload to the host computer, but also set up data acquisition sampling rate and quantization word length by the wireless remote control. The chart indicated that the basic functions of the system.
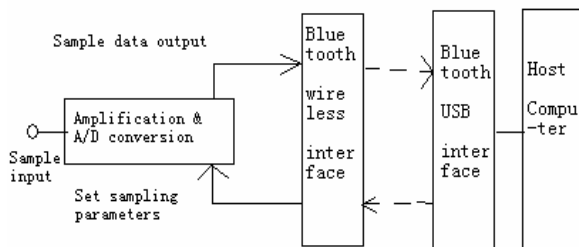

Figure 1. A/D sampling Bluetooth transmission system

With the relevant content of the system are too much, this article only introduced the hardware functionality of the system , and focused on the top of the data management and computer information processing functions.

2 The main performance indicators of system & technical point of Bluetooth.

In this paper, the performance indicators of the A / D data collection system is as follows:

(1) Sampling rate: this system is a low sampling rate system, the maximum sampling rate is 50K / s.
(2) Sampling accuracy: we Can choose to use quantitative 8, 12, 16 bit word length .
(3) Sampling channels: Each Bluetooth communication channel allows two-way channel. If you need more channels and you can use multiple sets of equipment
(4) Sampling input voltage range: <100 mV.
(5) Sampling input impedance:> 100 K Ω .
(6) Sampling module weight: less than 5 grams (including lithium batteries).
(7) Collection Module Size: 1cm $\times$ 0.7cm $\times$ 3cm. Bluetooth wireless technology guideline is used commonly . If there is no Bluetooth Interface on the host computer, Bluetooth Interface can be installed in the USB interface.
(8) 3.7V Li-ion battery power can be used about 8 hours.

3 To achieve the Data Acquisition System

The Process of data acquisition system:

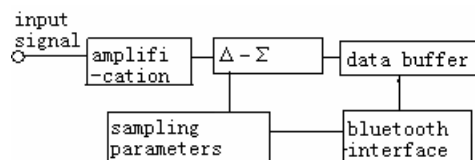In the process of A/D sampling, the Δ-Σ sampling is used to obtain high resolution or increase the sampling rate.

Figure 2. Data Acquisition System

4 Host computer data acquisition management & signal processing system

The host computer of the data acquisition system was built in Visual Basic 6.0 development platform. The host computer could use an ordinary desktop PC or notebook PC. This system mainly achieved two functions: One was the quasi-real-time waveform display of the sampled signal and the quasi-real-time display of the power spectrum; the other was that the sampled data was stored in the document in order to make further analysis and processing, a various of file formats allowed. (Quasi-real-time is allowing delay, but not data loss.)The host computer control and the main menu of acquisition system are as follows:

Figure 3. The host computer control and the main menu of acquisition system

The quasi-real-time sampled data was showed in the window in group which includes 512 data, so the delay was at least 512 data acquisition time. The power spectrum was obtained by FFT algorithm, also every 512 data as a group in the quasi-real-time display. The following diagram was a simple quasi-real-time waveform display.
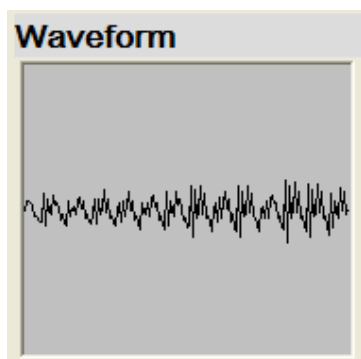

Figure 4. a simple real-time waveform display.

The power spectrum was estimated by periodogram algorithm. The following diagram was a simple quasi-real-time power spectrum display.
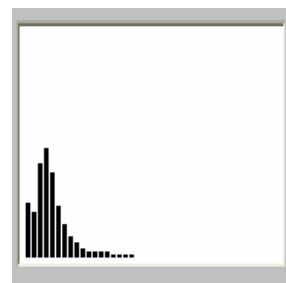

Figure 5. a simple power spectrum display.

The more important function of the host computer data management system was to store data collected in various file formats in order to facilitate the subsequent processing and analysis. A simple text file format could be set up as Figure6:
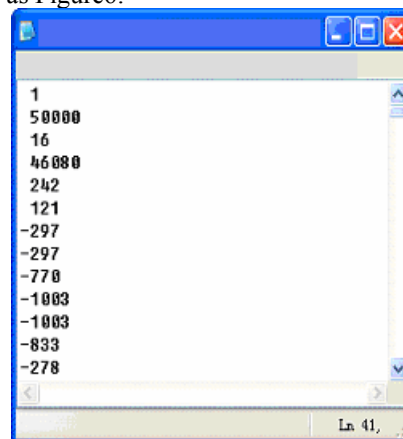

Figure6. A simple text file format

The *.txt file type can use tools such as Notepad of Windows to open and it is easy to observe the data values. The first line of the document shows sampled signal in one way, and the second line shows sampling rate. It was 50,000 samples per second. The third line shows the quantization bits, in this case was 16 bits quantization. The fourth line is the data length in this case it is a total of 46,080 sampling data. From the beginning of the NO.5 line stars sampling data and one data per line. Please pay attention to the name of the file was automatically named as "YYMMDD_HHMMSS" (year month day – hour minute seconds .txt). The time is the beginning of sampling signal, due to difference in timing of each samples, the file name will be united.

Because of there is a signal amplifier at the input of the hardware module, the sound signal can be input directly by a microphone. Then, we can get the sound signal with the sound file format which is as the Windows *.wav file.

The *.wav as the extension of the file format known as the waveform file formats. It is a multi-media resource for the exchange of resource, which is the RIFF. RIFF

that Microsoft definite is aiming at managing Windows environments of multimedia data file format and it composes of a number of the Chunk. In the document in accordance with the emergence of location, including: RIFF WAVE Chunk, Format Chunk, fact Chunk (optional), data Chunk. Specifically see figure 7:
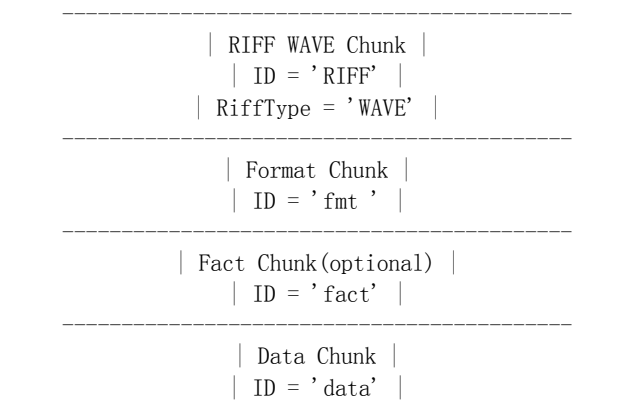
```
------------------------------------------
           | RIFF WAVE Chunk |
           | ID = 'RIFF'     |
           | RiffType = 'WAVE' |
------------------------------------------
           | Format Chunk    |
           | ID = 'fmt '     |
------------------------------------------
           | Fact Chunk(optional) |
           | ID = 'fact'     |
------------------------------------------
           | Data Chunk      |
           | ID = 'data'     |
```

Figure 7. the structure of wave file

The wave format chunk contains sample, which apart from Fact Chunk, the other three chunks is necessary. Each chunk has their own ID at the beginning chunk, which as marked with a size of 4 bytes. Keep up with the back of the ID is the chunk size with a size of 4 bytes, and the low-byte describe low value, high-byte value describe the high.

The RIFF block type of WAVE file format is "WAVE". It must include two sub-data blocks. A "fmt" sub-data block format used to store waveform information, including format waveform type, number of channels, sampling frequency, the median value and so on. The other is the "data" sub-data block, used to store waveform data information (ie, sample data).Otherwise, the "fmt" sub-data blocks must be in front of the "data" sub-data blocks. The system uses a sampling frequency selectable and 8/16 bit recording mode.

The RIFF block size of WAVE file equal to the total bytes of "fmt" and "data" sub-block, and equivalent to WAVE file size minus 8. The structure of "fmt" sub-block is posed by PCM WAVE FORMAT. Its sub-block size is size of (PCM WAVE FORMAT), and the data is composed of PCM WAVE FORMAT data. Shown in figure8:
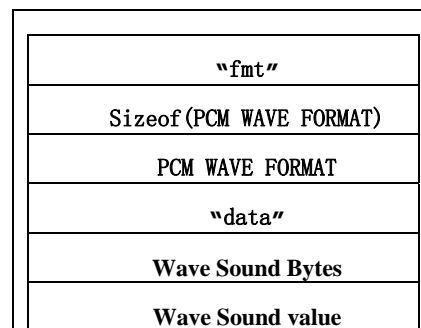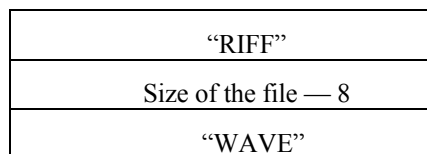
"RIFF"
Size of the file — 8
"WAVE"

"fmt"
Sizeof(PCM WAVE FORMAT)
PCM WAVE FORMAT
"data"
Wave Sound Bytes
Wave Sound value

Figure 8. Wave File Header

Visual Basic 6.0 has designed a set of input-output function of multimedia files. It Provides buffering and non-buffered input and output operation of multimedia files that can support a good read and write operation for RIFF files. In this design, we has analyzed the wave form and verified all of the document chunk, including RIFF files (Resource Interchange File Format), wave file, fmt logo, as well as the location of data and documents length. Mapping of the waveform data are as follows:

Figure 9. Sound wave

5 The downlink channel of Bluetooth for sampling parameters

Data collection required sampling parameters by the request .The system was not setting button in the sampling hardware module and there was no program of display system. Then a more compact module would exist. The sampling was controlled by the host computer. Taken advantage of the duplex communication of Bluetooth, the wireless network using the downlink channel to control the sampling module. The Control functions of the system were mainly the beginning and end of sampling control, sampling rate settings, sampling to quantify the length settings and sample channel settings. The man-machine interface of host computer settings were as follows:
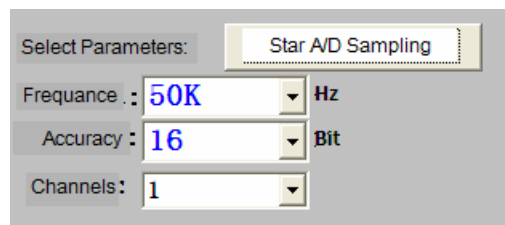
Figure 10. Sampling parameters

In the Bluetooth module was equipped with power switch. When we opened the switch, a Bluetooth network connection request information was issued. So when the host computer was turned on, it would automatically select the channel connected with the sampling module. If there are multiple Bluetooth systems, the host computer can select the equipment needed to be connected by artificial selection. As the sampling module has only two channels, if we had more than two channels at the same time, we need to use more sampling modules. The Bluetooth system can automatically choose a frequency channel for data transmission and will not interfere with each other.

The data collection that decreased slowly for a long time (several hours to several days), the system set up a continuous acquisition program. After setting the discontinuity time and sampling time, the system will do the continuous sampling in accordance with the setting. Thereby it reduced the data storage space and system power. The discontinuous function was used the VB timer component to complete. The setting of discontinuous sampling was as follows:
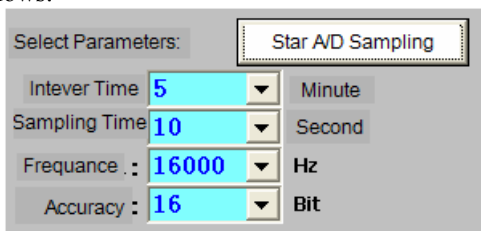

Figure 11. The discontinuous sampling

6 Data mapping and Save the file

After the completion of A/D sampling, we must achieve the process of data mapping. Click on the user interface of the system of "data mapping", then the system would automatically pop-up file directory window. Selected the data file and the system would automatically map the data waveforms.(Figure 12)

Figure 12. Data collection wave

In addition, the wave file header could also display the main parameters. With the "redraw" function(Figure 13), the waveform could be magnified to the corresponding multiplier in order to observe the waveform more closely.

Figure 13. Redraw graphics pro-rata

In this system, in order to facilitate further research and processing, the data file could be saved and conversed as various of file formats.

7 Conclusion

When we collect the analog signals, this system use Bluetooth wireless data transmission network. It can achieve the signal acquisition on the movement objects. Furthermore, the sampling parameters can be set up. The system can display the sample data and power spectrum of the waveform in quasi-real-time, and save the sampled data as varies of other formats. Because of its ordinary host computer, for further use of various high-level language and tools are very easy to deal with. In addition, the sampling module fixed on the moving object only has a few grams of weight. It lighten the burden of the campaign and with good usability.

At present, the system only suitable for the conditions of sampling rates no more than 50KH/S. If we need for a higher sampling rate, it is necessary to improve the design.

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