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Remote Control and Data Compression -based Wireless Data Acquisition System

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ABSTRACT

The wind field measurement for severe winds such as hurricanes (or typhoons), thunderstorm downbursts and other gales is important issue for wind engineering community (e.g., Balderrama et al. 2011). Although the wind field measurement acquisition in the remote area such as the bridge site in mountain area is addressed by Huang et al. (Huang et al. 2015), it has a need to further improve such a system. In this study, a wireless high-frequency instrumentation system with the functions of remote control and data compression was developed. The system structure and working principle of the collector are presented. Then the features of this newly-developed system are compared with the existing data acquisition systems. Finally, its application to the field is discussed in detail.

1. INTRODUCTION

Over the last decade, more and more information acquisition and remote control system use a wireless data transmission technology (Otero et al. 2009; Subramanian et al. 2011). Compared with wired data transmission technology, it has advantages of wireless collection, easy installation, and moving conveniently. Although existing wireless collection systems can acquire directly all data from anemometers in distance, apparently, it may not be very suitable for obtaining the high-frequency fluctuating wind time history in remote areas due to much data and poor working conditions.

In order to be more convenient and efficient for the measurement of wind field in remote areas, this paper develops a high frequency wind speed acquisition system with remote interaction and data compression function. First, the structure and working

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principles of the system are described in detail. Then, the interactive and data processing functions and other functions are introduced. Finally, the system is compared with other existing wireless data acquisition systems.

2. SYSTEM STRUCTURE AND PRINCIPLE

2.1 Overall Layout

The wireless anemometry system mainly includes the collection part and the client part, as is shown in Fig. 1. Anemometer, collector and power supply device constitute the collection part. The data from the anemometer is transmitted to the collector by the RS485 cable. Solar cells are used as a power supply device for the anemometer and collector. The client part is mainly the cloud server, and other terminal based on the cloud server, such as mobile phone app, mailbox, etc. The collection part and the client part are connected through the wireless communication based on GPRS wireless network between cloud server and collector. Mobile app is mainly used for real-time monitoring system, waning instructions, etc. The mailbox is mainly used for the user to obtain the data and other information that can be used directly.

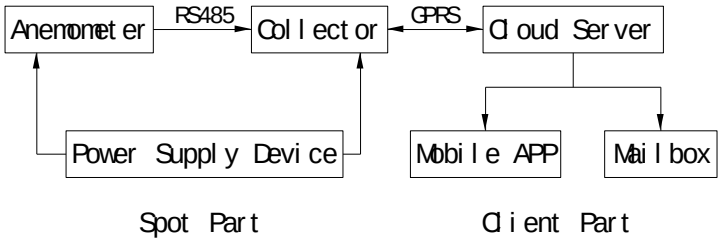
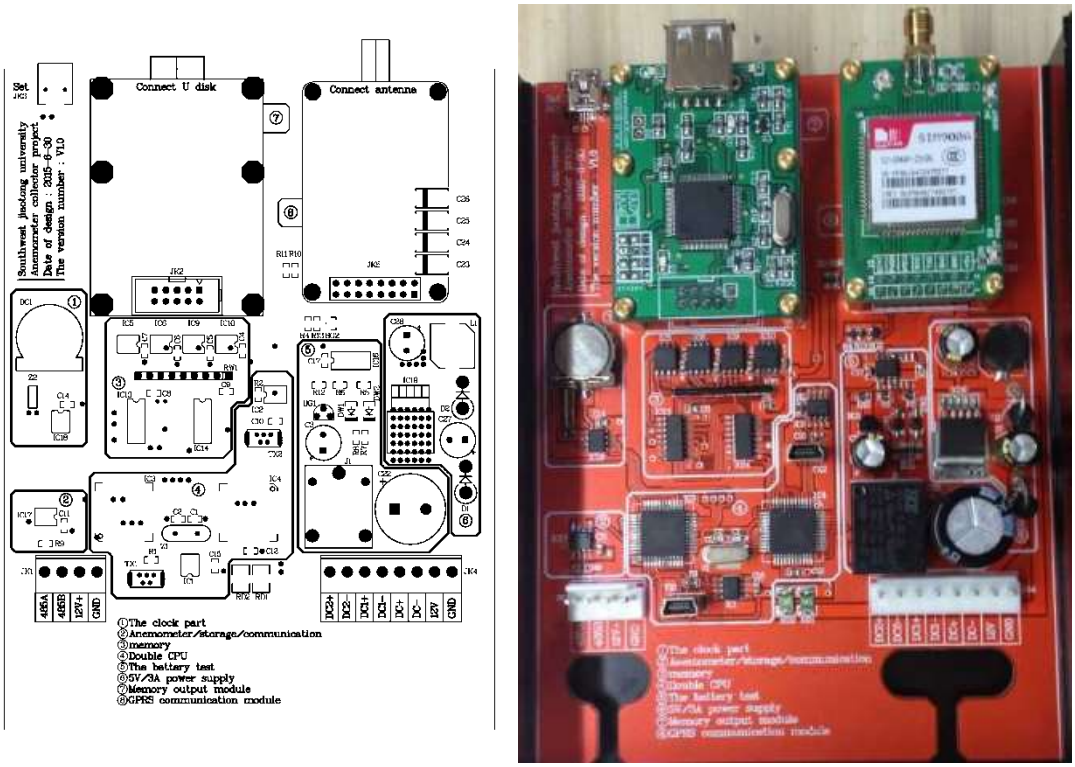


Fig. 1 System structure

2.2 Structure of the Collector

The collector is composed of SCMs (single chip microcomputer) based on integrated circuit technology, as shown in Fig. 2. It mainly consists of 8 working elements. In order to obtain the wind speed data that contain the time, clock is necessary to process the raw data. We need communication transform interface to switch the format of the data from the anemometer into the format which can be recognized by the collector. Central processor controls the whole work process. The “Data CPU” controls the collection, processing and storage of the data, and the “Transmission CPU” controls the transmission of the data and the monitor of the power. The two CPUs develop mutual cooperation through internal communication, in order to avoid disorder of multiple instructions. Internal cache is a place for temporary storage of data that waits for being transmitted. By using cache, transmission of data becomes more efficient. Users can know the working condition of the battery in time through power monitor unit. Memory controller is used to store all the output data from

anemometer. Communication module is executor of the data wireless transmission.



(a) (b)

Fig. 2 the structure of the collector: (a) design; (b) object

The working process of the core components of the collector is shown in Fig. 3. Firstly, the data from the anemometer is added to the time parameters through clock. Then, on the one hand, the data with time is stored in the external storage device linked to the collector through memory controller. On the other hand, the data with time that has been selected and compressed by the “Data CPU” is stored in the internal cache. At last, the “Transmission CPU” sends the data stored in the internal cache and the information of the battery working condition from power monitor to the remote cloud server through the communication module.

What’s more, the communication module could receive orders from users and send them to the “Transmission CPU”. Then, the “Transmission CPU” sends the orders further to the “Data CPU” through internal communication. Hence, the parameters of the collector can be reset according to the user’s need.

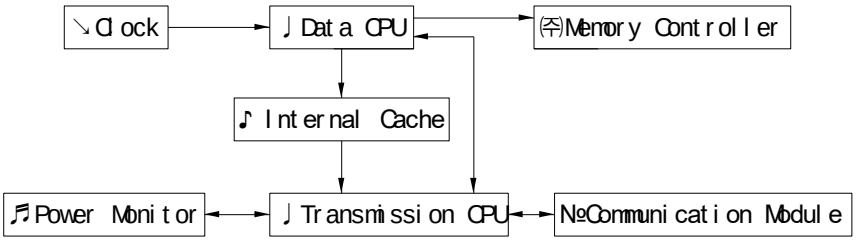


Fig. 3 Working principle of the collector

3. MAIN FUNCTIONS OF THE COLLECTOR

In addition to the feature of hardware integration mentioned above, in practical application, there are also many convenient and practical functions for the collector.

3.1 Interactive Function

As mentioned before, through the communication module of the collector, the data from the anemometer can be transmitted wirelessly to users' cloud server. Reversely, the cloud server can send controlling commands to the collector. They may include the frequency of collecting data, the minimum wind speed (wind speed threshold), data items which need to be transmitted, and so on, e.g. see Fig. 4.

Through the interactive function, data that only users need is transmitted, which greatly extends the range of application of the anemometer system and improves the efficiency of data transmission.

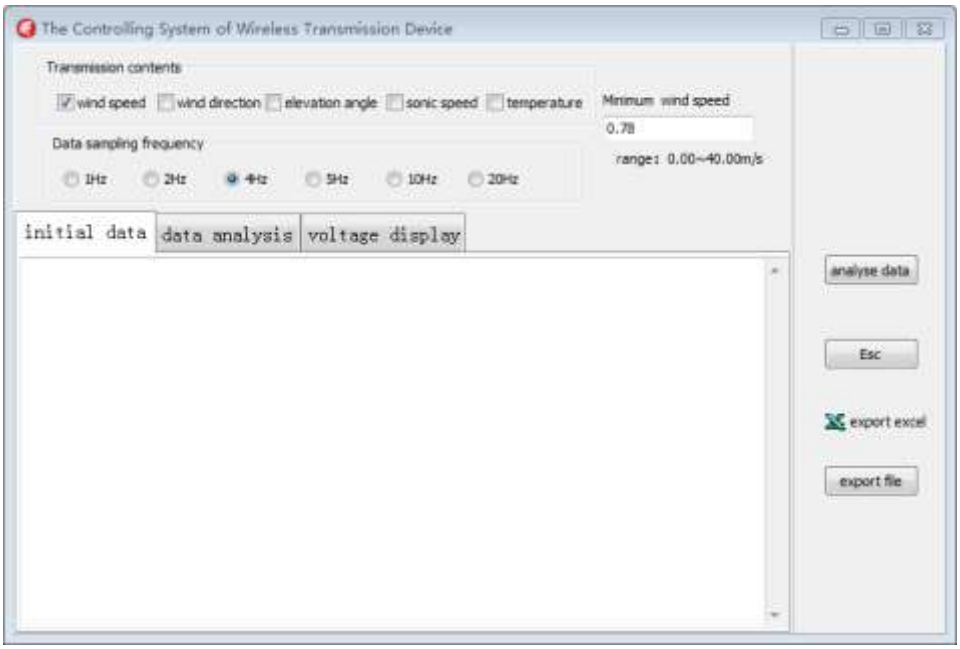


Fig. 4 Remote controlling interface

3.2 Data Compression Function

As mentioned before, we want to obtain the wind speed data that contain time. Simply, we just add time to the first set of data every second, and the time parameters include hours, minutes and seconds, all of which are only recorded once. That is to say, when the adjacent two time parameters have the same hour or minute, the latter will be omitted. Whatever the collection frequency is, the first set of data per second will be selected out, so all data with time parameters will be collected by this way, which is accurate and efficient. As for the date of the data, a document named after the date is established every day to save the data of the whole day, e.g. see Fig. 5.

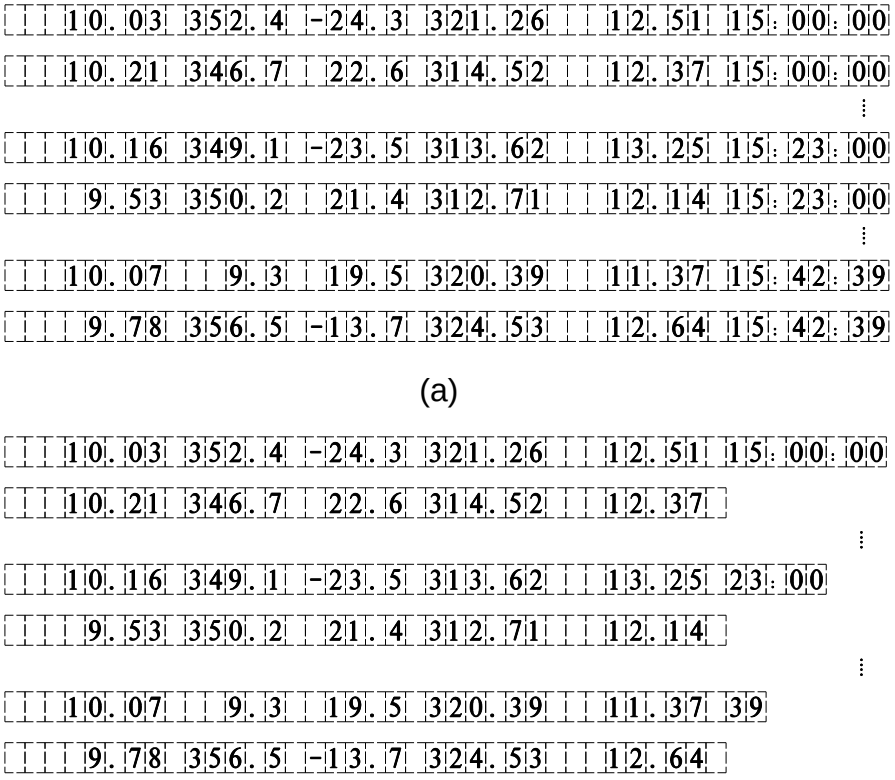


Fig. 5 Comparison of two methods of adding time parameters (collection frequency: 2HZ): (a) the traditional method; (b) the latest method

As the output data of the Young81000 shown in Fig. 6, each set of data contains some redundant space characters and the decimal points in some fixed position. These characters also produce transmission flow, so removing the redundant characters can reduce the transmission flow, and it doesn't have any impact on the transmission results.

Also, according to the characteristics of the output data of the anemoscope, the transmission of data, combined with the hexadecimal conversion, can be further

reduced. Every two continuous effective digits can be converted to hexadecimal number. Hexadecimal "1" is used to represent the negative sign, and hexadecimal "0" means positive sign. The first effective digit of sound velocity must be 3, so it can be ignored.

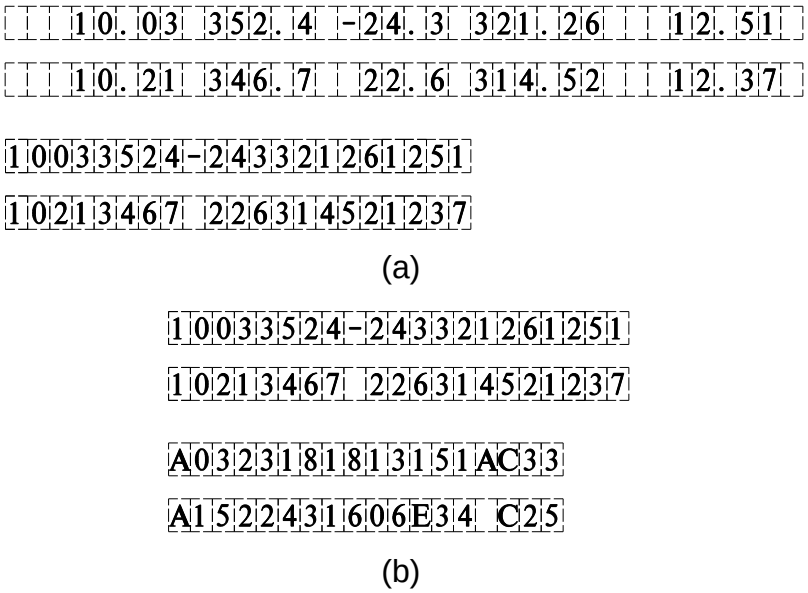


Fig. 6 (a) Remove of redundant characters and (b) hexadecimal conversion

In addition, users can also use interactive function to not transmit the needless data, which also reduces the transmission flow to some extent. In general, through data compression and interactive functions, the transmission efficiency is greatly improved, meanwhile transmission flow reduces clearly.

3.3 Other Functions

Based on the actual needs for users, more convenient and practical functions are provided. The system generates performance log to ensure that the user can make appropriate judgments to the received data. Through emergency alarm function, some emergency or important situations that may occur during the operation of the system will be notified to users in time. Users can check conveniently real-time wind data and other information such as the voltage and fault conditions and so on by mobile phone app function.

4. COMPARISON

There are also many existing wireless acquisition systems to collect high-frequency fluctuating wind. Last system developed by Huang et al. (Huang et al. 2015) combines collector with wireless transmission devices, and has been applied to the actual mountain wind speed measurement. Others are the collector with data transmission

function, such as CR3000 and NI CompactRIO. Tab. 1 compares four existing wireless acquisition systems, and it shows that the latest acquisition system has been significantly improved, especially the interactive and data compression processing functions.

Tab. 1 Comparison of different wireless data acquisition systems

Properties	Last system	CR3000	NI CompactRIO	Latest system
Integration	no	yes	yes	yes
Interactive	no	no	good	very good
Compression	no	no	no	very good

5. CONCLUSIONS

Compared with the existing data acquisition system, this system has obvious advantages and broad application prospects. Firstly, the field equipment is simple, portable, and easy to install. Then, the parameters of collector can be easily modified by the client. Furthermore, it can save resources by efficient transmission. In addition, mobile App makes the operation more flexible and convenient.

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