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Wireless Communication of Construction Machinery Signal Based on the Bluetooth Technique

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Abstract-Because the traditional centralizing collection and cable transmission can not meet the requirement to measure the multiple parameters of construction machinery wirelessly, according to the networking, centralizing, distributing and smart status of data collection system, the measurement system using distributed data collection and wireless Bluetooth technology is designed to accomplish the task of the design of the signal transmitter and receiver.

Keywords- Bluetooth technology;wireless communication; construction machinery;USB

1. Introduction

The multiple parameters of construction machinery include torque, displacement, hydraulic pressure, temperature, revolution and noise are need to be measured wirelessly. Due to the distraction of the parameters and the running status of the working part to be measured, the traditional centralizing collection and cable transmission can not meet the actual requirement.

The wireless Bluetooth technique is the simplest and most convenient method that two devices communicate wirelessly in short distance. It has been applied widely in many devices such as mobile phone, notebook computer, printer and premium earphone. The Bluetooth technique has the advantages of miniaturization, wireless, low power and low cost, embedded security, stable, easy to use and networking timely. The wireless communication of Bluetooth networks such devices as a Piconet. Multiple Piconets can be connected to communicate wirelessly between devices anywhere and in anytime. The wireless measurement scheme based on the Bluetooth technique can solve the problem of data transmission in production field under short distance and complex circumstances, and enhance the reliability and convenience of construction and controlling devices. Thus the automation level of construction engineering is increased and the reliable and valid information of secure production are provided. Under this circumstance, the features of the Bluetooth technique in wireless measurement are researched and wireless communication based on Bluetooth technique is designed and realized. It provides technical support for smart surveillance and information management of construction engineering and is of great value to the wireless measurement of multiple parameters of construction machinery.

2. 3-Level Communication Protocol of Wireless Receive and Transmission

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According to the actual need, the hardware system of wireless measurement system includes collector and controlling part. The collector hardware includes signal collection and transformation model, processor model, Bluetooth communication model, power supply model and USB interface. The system solves the problem of wireless measurement of multiple parameters in the working process of construction machinery, in which the Bluetooth model and controlling part communicate according to the promissory protocol to realize the wireless control of controlling part to collector and wireless receive and transmission of collecting data.

Communication protocols include transport layer protocols, intermediate layer protocols and application layer protocol.

2.1. Transport Layer Protocols

Bluetooth uses a variety of protocols. Core protocols are defined by the trade organization Bluetooth SIG. Additional protocols have been adopted from other standards bodies. This article gives an overview of the core protocols and those adopted protocols that are widely used.

1) Radio Layer

When looking at the different layers of the Bluetooth protocol stack, you will always find the radio layer first. Everything in Bluetooth runs over the Radio Layer, which defines the requirements for a Bluetooth radio transceiver, which operates in the 2.4GHz band.

2) Base band Layer

The next "floor" in the Bluetooth protocol stack is the Base band Layer, which is the physical layer of the Bluetooth. It is used as a link controller, which works with the link manager to carry out routines like creating link connections with other devices. It controls device addressing, channel control (how devices find each other) through paging and inquiry methods, power-saving operations, and also flow control and synchronization among Bluetooth devices.

3) Link Manager Protocol

A Bluetooth device's Link Manager Protocol (LM) carries out link setup, authentication, link configuration and other protocols. It discovers other LMs within the area and communicates with them via the Link Manager Protocol (LMP).

4) Host Controller Interface

Next in the protocol stack, above the LMP is the Host Controller Interface (HCI), which is there to allow command line access to the Base band Layer and LMP for control and to receive status information. It's made up of three parts: The HCI firmware, which is part of the actual Bluetooth hardware; The HCI driver, which is found in the software of the Bluetooth device; The Host Controller Transport Layer, which connects the firmware to the driver.

5) Logical Link Control and Adaptation Protocol

Above the HCI level is the Logical Link Control and Adaptation Protocol (L2CAP), which provides data services to the upper level host protocols. The L2CAP plugs into the Base band Layer and is located in the data link layer, rather than riding directly over LMP. It provides connection-oriented and connectionless data services to upper layer protocols.

2.2. Intermediate Layer Protocols

The intermediate layers should provide the ability to transfer data without intimate knowledge of the data being transferred. Several different layers defined initially for Bluetooth can be used:

1) COM Port Emulation

COM Port Emulation enables virtual COM ports to be created over RFCOMM channels. It hosts dial-up and LAN access profiles.

2) Service Discovery Protocol

SDP (Service Discovery Protocol) is a Bluetooth service discovery protocol that handles publishing and discovery of services running on top of the Bluetooth stack. The port emulation includes SDP client module and SDP server module.

3) Telephony control protocol

Telephony control protocol-binary (TCS BIN) is the bit-oriented protocol that defines the call control signaling for the establishment of voice and data calls between Bluetooth devices. Additionally, TCS BIN defines mobility management procedures for handling groups of Bluetooth TCS devices.

TCS-BIN is only used by the cordless telephony profile, which failed to attract implementers. As such it is only of historical interest.

2.3. Application Layer Protocol

Application layer protocols are defined by other standards-making organizations and incorporated into Bluetooth's protocol stack, allowing Bluetooth to create protocols only when necessary. The application layer protocols include:

1) Point-to-Point Protocol (PPP)

Internet standard protocol for transporting IP datagram's over a point-to-point link.

2) TCP/IP/UDP

Foundation Protocols for TCP/IP protocol suite.

3) Object Exchange Protocol (OBEX)

Session-layer protocol for the exchange of objects, providing a model for object and operation representation

4) Wireless Application Environment/Wireless Application Protocol (WAE/WAP)

WAE specifies an application framework for wireless devices and WAP is an open standard to provide mobile users access to telephony and information services.

3. Implementation of Bluetooth Communication System

3.1. Institution of Bluetooth Communication

The main function of Bluetooth model in this paper is communication with controlling port according to the binding protocols to realize the wireless control of controlling part to collector and wireless receive and transmission of collecting data. Thus the Blue Core IC made by CSR company is selected. The diagram of Bluetooth wireless communication is shown as figure.1.

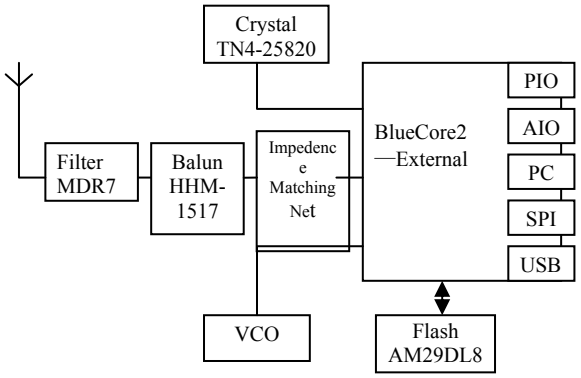

Fig.1 The diagram of wireless communication of Bluetooth.

3.2. USB Interface

In this scheme, the USB interface is selected as the HCI (Host Controller Interface) of the Bluetooth system, and the embedded processor is used to control the COMM communication and coordinate the interface between USB appliance and application devices. Usually the embedded processor provides 80% or more free resources for application devices. Therefore, the saved resources are used to run LC to spare a premiere processor. Thus the system cost is greatly reduced.

When USB interface is adopted, the blue core IC is used as a slave device communicated with host, which conforms to the USB 1.1 criterion. This criterion has a speed of 12Mbit/s at full speed, and a speed of 1.5Mbit/s at low speed. The interface circuit is shown in figure.2.

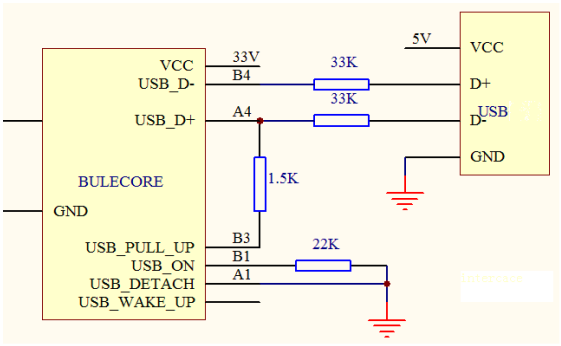

Fig.2 The interface circuit of USB.

When the type is used, the USB-PULL-UP (B3) pin of the blue core IC outputs a high level at 3.3 voltages, which is connected to the D+ port of USB interface via a pull-up resistor of 1.5KΩ. Then the blue core IC serves as a full speed device connected with host. It is notable that the USB interface provides four control ports include USB-PULL-UP, USB-WAKE-UP, USB-ON and USB-DETACH. In the USB mode, the USB-WAKE-UP port outputs high level to wakeup the host, which there is no such a port in simple interface. When USB-ON is input high level, the blue core IC is activated. When USB-DETACH is input high level, the chip detaches the USB mode.

3.3. Design of RF Circuit

The RF input port of BlueCore2-External IC can be configured as difference mode or single port mode via modifying the PSKEY_TXRX_PIO_CONTROL value of Persistent Store Key. The class 1 model uses the single port mode, while the class2 model uses the difference mode. The communication distance of class 1 can achieve 100m, and the distance of class 2 is 10m. So class 1 model is adopted to meet the requirement of the 100m distance communication, which can be seen from figure.3.

Impedance matching net is need between the difference port of BALUN, TX_A and TX_B ports. BALUN is the converter from balance status to unbalance status, which converts difference signal to single port signal. Then the signal is transmitted via antenna after the band-pass-filter. The LC filter circuit protects the RF signal against the power source signal.

The band-pass-filter can restrain the interference to the transmission circuit. The selection of band-pass-filter depends on different application. BALUN must be the component to restrain common mode rejection ratio effectively to prevent from reduce the modulating characteristic of signal. The BALUN product HHM-1517 made by TDK is used in this design.

4. Conclusions

In this paper, the wireless hardware model of measurement system of construction machinery based on wireless Bluetooth technology to realize the control of controlling port to the collector and the wireless receive of collection data. Thus the wireless transmission function of the measurement device in workplace

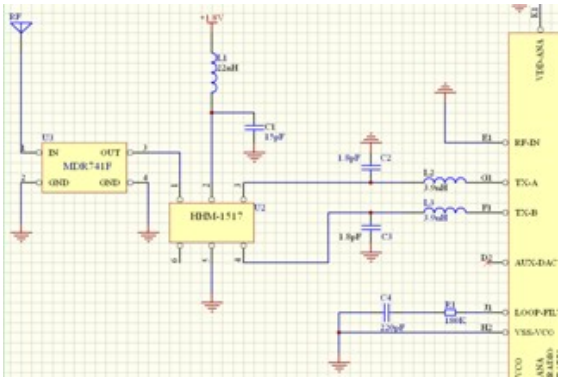

Fig.3 The RF circuit of class 1 model in single input mode.

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