

# Environmental Monitoring System for Base Station with Sensor Node Networks

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**Abstract**—A Practical application of environmental monitoring system based on wireless sensor node network with the core of embedded system STR711FR2 microprocessor is presented in the paper. The adaptable and classifiable wireless sensor node network is used to achieve the data acquisition and multi-hop wireless communication of parameters of the monitoring base station environment including repeaters. The structure of the system is proposed and the hardware architecture of the system is designed, and the system operating procedures is proposed. As a result of field test, designed hardware platform operated with 50kbps bit rate and 5MHz channel spacing at 2.4GHz. The wireless monitoring system can be managed and swiftly retreated without support of base station environmental monitoring.

**Index Terms**—base station, wireless environmental monitoring, transceiver, interface, sensor networks.

## I. INTRODUCTION

With the rapid improvement of modern industries and the continual growth of wireless communication, the request of base station management for a remote monitoring environment is progressively changed. But, the difficulty of environmental circumstance has become increasingly serious at the same time. So the environmental monitoring is the fundamental course to solve this inconsistency. The main object of the environmental monitoring is to reflect the quality of the environment status and its development trend of

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the accurately, timely and comprehensively for providing the technical basis for the environmental management, remote control and environmental planning, etc. [1]-[5]

The effects of influence on the parameters such as output power level or temperatures of environmental management can be completely understand and the exact evaluation of the data quality can be further made by just only monitoring of the state of the environment.

Repeater or wireless base station environmental monitoring is a very important part in the wireless remote monitoring. Over the monitoring the output power level as well as the board temperatures which impact of the base station management, the basic data and information are provided for analysis of remote control unit and adoption of the control methods [2].

A practical application of wireless environmental monitoring system with wireless mesh network based on embedded system is presented in this paper. The system with the core of STR711FR2 can real-time monitor the parameters such as output power level in dB as well as temperature, humidity, air pressure, etc. of the base station interior environment and send the acquisition data parameters to the wireless monitoring centre through the mesh network.

The embedded system was applied as the core with the association of wireless mesh network technology, which can reduce the cost and improve the efficiency of the monitoring system. [3]

Through the preceding research, the wireless environmental monitoring system based on the sensor node network can achieve the fast management in a regional of the environmental monitoring network and make possible maximum use of the function of dynamic classifying nodes to confirm the connection in the wireless sensor network at any time without affection on the entire network. [4]-[5]

Collected data parameters in the wireless sensor network including sink and sensor nodes communicate through multi-hop to maintain the capabilities and high robustness of the entire network, and achieve the real-time measurement and transmission capabilities of the data. Accordingly, the system provides practical managements for the wireless repeater or base station monitoring. [6]

## II. STRUCTURE OF THE SYSTEM

The wireless monitoring system is mainly consisted of the data acquisition unit, signal processing and storage unit, RF transceiver unit and the power supply unit, etc. In the system configuration, the core of STR711FR2 microprocessor expanded with the memory and HotPort wireless mesh module as well as external support circuits to achieve the multi-point and real-time monitoring of the parameters of the base station environment in the monitoring region such as output power level as well as temperature or humidity etc. [7]

The overall system nodes block diagram of the environmental monitoring system is shown in Figure 1.

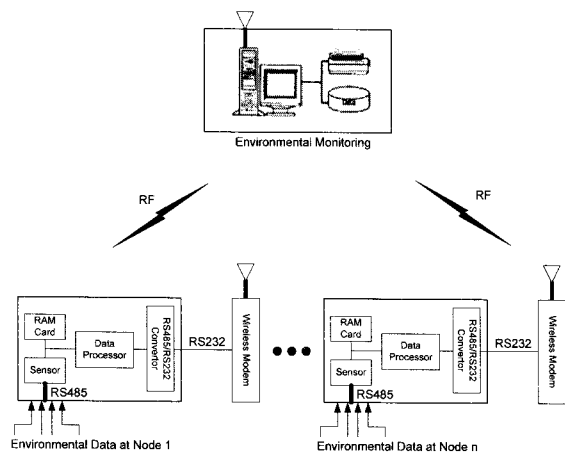


Fig. 1 System block diagram of the environmental monitoring system in base station.

STR711FR2 is used as the whole control centre of the monitoring system. On one hand, it receives the measurement data from the sensor and processes and computes the data according to the requirement and transfers them into the communicating module to send, on the other hand, it reads out the information from the communicating module to accordingly manage the hardware modules.

We use the high performance mesh network node module as the wireless communication module. The outside expanded memory are used to store the operating system kernel and collecting data, or the 21-channel 9600-bps ADC is used for analog to digital conversion.

The power supply unit utilizes high performance batteries for the entire power supply of the system.

Table 1 shows the specifications of the hardware platform. [8]-[9]

Table 1 Specifications of the hardware platform.

|            |                           |
|------------|---------------------------|
| Processor  | STR711FR2                 |
| Memory     | 256KB                     |
| RAM        | 64KB                      |
| RF Module  | Chipcon                   |
| Modulation | O-QPSK                    |
| Data Rate  | 50kbps                    |
| Sensor     | Output power, Temperature |
| Interface  | Serial                    |
| Power      | 3.0V                      |

## III. TRANSCIEVER BOARD DESIGN

In the field of the wireless base station monitoring, we consider several node units which consists of sensors, microprocessor and wireless module unit. These nodes compose the wireless mesh network according to the protocol. Every unit in the network is a communicating node. The hardware design of the node unit will be introduced below in detail.

RTU block as shown in Fig. 2 is consist of input and output port, A/D convertor, interface board, data communication, RAM, etc.

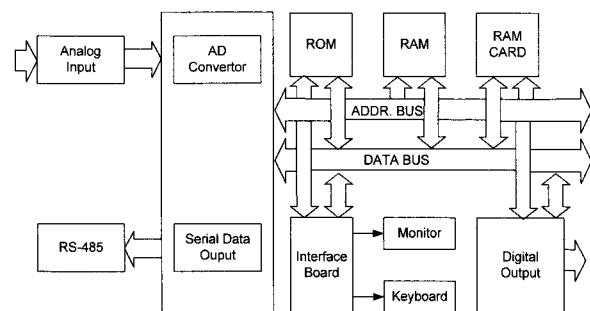


Fig. 2 RTU block diagram.

STR711FR2 including 16kbyte EPROM can record the data acquisition time and has high speed capture function

According to the main task of the wireless base station monitoring, we select the concentration of output power level at NMS board as well as temperature, humidity and other parameters of the base station environment as the main monitoring parameters of the system, and can use sensors in accordance with the physical characteristics of the monitored parameters.

The data acquisition module is composed of all parameters measuring sensor using serial data format as shown in Fig. 3.

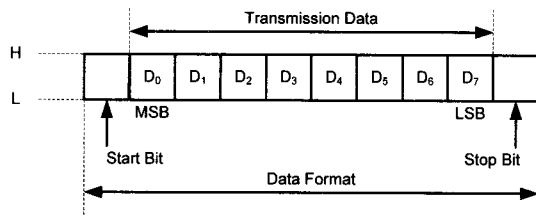


Fig. 3 Serial data format.

In general, RS485 communication is able to multiplex in data acquisition or storage, but PC couldn't support the RS232 method. Therefore special RS232/485 converter introduced for bidirectional communication between monitoring computer and data acquisition board as shown in Fig. 4.

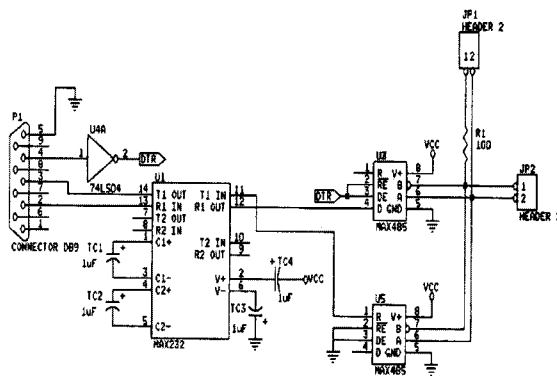


Fig. 4 RS232/485 Converter.

Data in both collecting and storage are distinguished by synchronous and asynchronous data according to the transmission status. Synchronous data such as output power level, temperature or humidity in NMS board has periodic characteristics, while asynchronous data such as alarm signal has not periodic characteristics. Therefore, it is needed to configure the alarm data packet to small size compare with data packets.

We adopted data packet frame consist of preamble, destination address, source address and CRC as shown in Fig. 5.

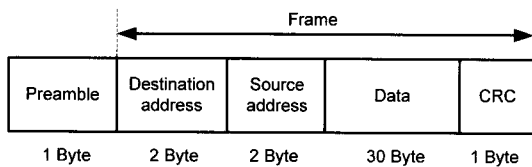


Fig. 5 Data packet frame.

Sensor nodes used in wireless sensor networks are consists of processor, transceiver, power unit and sensor. The most important strategy in the sensor node is low cost and low power. Maintenance cost at each sensor node could be increased with high power consumption system.

Hence, STR711 series processor of ST was adopted in our sensor node design which has several power saving functions of Slow, Wait, Stop, Standby. General purpose RF Transceiver, CC2420 of Chipcon was used and ADC block inside STR711FR2 connected between sensor interfaces. Hardware module is connected by UART protocol with serial port to host in sink or sensor node condition.

According to the requirement of data collecting tasks, the wireless network environmental monitoring system proposed based on sensor network. In the test network, each sensor node and sink node is included, and the sink nodes operated as a monitoring node concerned with lower level sensor nodes.

Normal communication status between sink node and sensor node is evaluated by terminal program at the host. The network consists of 1 sink node and 3 sensor nodes with serial interface for host to sink interface. PC is used as a host. [6]-[7]

Data transmitted from sensor node such as output power level, temperature or humidity are integrated via IEEE802.15.4 wireless communication packets with serial port as shown in Fig. 6.

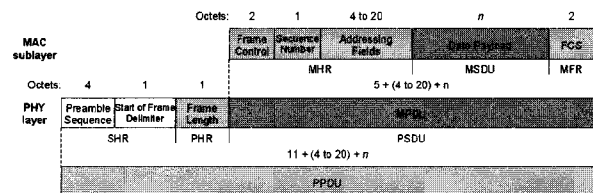


Fig. 6 IEEE 802.15.4 Data frame.

The main task of building the wireless mesh network is to do the coverage of the wireless mesh nodes to fill the monitoring region with the wireless RF signals. Each node in the mesh network can provide with routing functions and only communicate with the neighboring nodes.

To the larger regional coverage, data transfer from one route to another route while also reduces the power consumption of each mesh node. The entire network can access to Ethernet or the Internet through the access point so as to achieve the interconnection between wireless LAN and the external networks. [8]-[9]

According to IEEE 802.15.4 protocol, we designed hardware platform having 5MHz channel spacing with

16 channels at 2.4GHz.

We used commercially developed graphic user interface for field test as to the hardware platform and detected sensing parameters 31.8dBm of forward output power level for WCDMA and 25.4dBm for CDMA and 39°C of temperature as shown in Fig. 7.

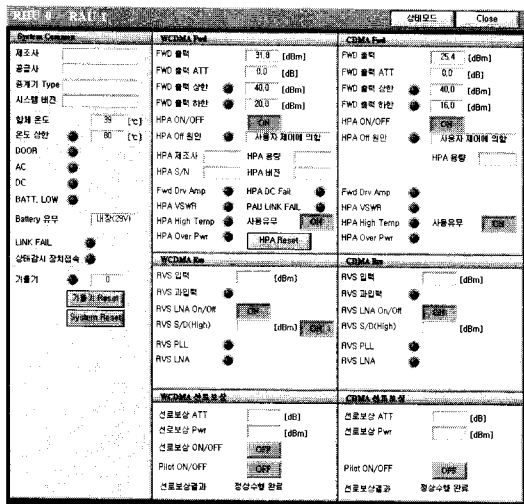


Fig. 7 Field test result.

The sensor network configuration is shown in Fig. 8.

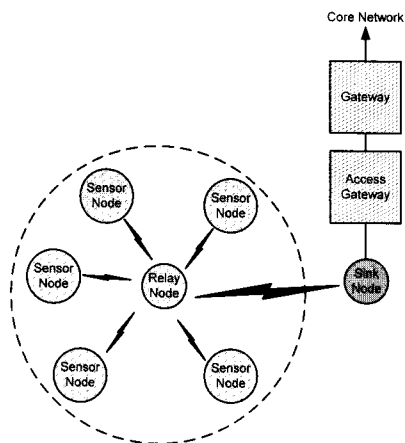


Fig. 8 Sensor network configuration.

The monitoring system collection node designed in the paper is jointly composed of mesh node in the network, data acquisition sensors and microprocessor. However, the separate mesh node can also be arranged in the network for data routing functions specifically to provide a reliable service for the data transmit of other nodes.

All the mesh nodes can automatically search for other nodes in a certain range after power up to build

the wireless mesh network. Therefore, expanding the network coverage is very simple as long as electrifying the new node in the existing coverage of other nodes.

We can also interconnect several mesh networks to cover a larger area. Each node transmits the collected data by wireless means to the other nodes in the vicinity and then other nodes continue until the data reach the network access point. [9]

We can also know from the Fig. 7, the data of sensor node will be transmitted to the monitoring centre through relay node, sink node and access gateway. The access point passes the data through to external network or monitoring center. Between all the mesh nodes, there are a number of communicating channels to make it possible to maintain the flow smooth. If there's individual node failures or disconnected, the network will self-heal and ensure that the monitoring center can access to all of the mesh nodes in the remote.

#### IV. CONCLUSIONS

In this paper, the environmental monitoring system based on embedded system which was advanced can collect and store parameters of output power level and temperature, humidity air pressure etc.

The monitoring system which is with a core of STR711FR2 improves processing speed and declines system power consumption. Using wireless node network can build network according requirement smartly. Multi-data remote measurement is realized through multi-hop wireless communication.

As a result of field test, designed hardware platform operated with 9,600bps data rate and 5MHz channel spacing at 2.4GHz.

Data collection node can be added and evacuated from the network at any moment without influence other node data transmission, therefore the capability of self-healing and robustness of the whole network has been improved.

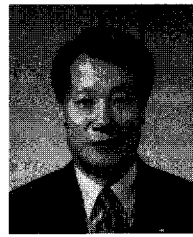
This environmental monitoring system which is used in base station can satisfy requirements of wireless environmental parameter monitoring.

#### ACKNOWLEDGMENT

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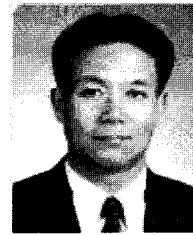
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