Proposals of Optical and RF Hybrid Wireless Communication Without Packet Traffic Collision

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1. INTRODUCTION

To pursuer high production efficiency and reduce the cost as possible, it is more and more important that using the network technology for the control of the equipments or communication between equipments or trace abilities in industrial field. The network is constructed with the high cost communications cable for high reliability, but there is a problem of the restriction for the construction cost and the construction period, and the available space for wiring. Recently, as an advance of RF communication technology, wireless communication network with use of RF increases greatly. With use of the wireless network in the manufacturing process, it is expected that investment cost, operation cost and production cost can be reduced. Therefore, if reliability and real time property of the communication can be guaranteed, a flexible and low cost manufacturing process can be achieved.

The typical RF wireless communication used widely are Wi-Fi, (WLAN, Bluetooth etc.) and sensor network, which provide some good communication functions for many applications, but the WLAN and other wireless communication often have a traffic collision problem, if there are a lots of terminals sharing the same channel. Although some approaches have been taken to provide the collision avoidance, when the amount of terminals increases the probability of collision may increase greatly, and the throughput will be affected greatly also. The wireless communication used in industry is required with not only high reliability but also a property of real-time.

In order to provide a wireless communication that can connect more than several hundreds of equipments, we present a new wireless communication architecture that combines optical space communication (OSC) and RF communication. We call it a hybrid wireless communication. In this new hybrid wireless system, the traffic collision problem can be avoided completely; therefore both reliability and real time property can be obtained.

2. SYSTEM OVERVIEW

For a typical industrial application, such as assembly line, only very small data are need to be transferred between several hundreds terminals and upper level controller. Here we consider a system as shown in Fig.1. In this communication environment, a master device have to control more than several hundreds slave devices. Also the master device will send the slave information or get control information from upper layer. For the wireless communication connection, WLAN or Bluetooth, or sensor network can be used. It is well know that WLEN can provide a fast data link for many users, but the throughput will be reduced greatly for limited channels and collision happened. With its collision avoidance algorithm, the packet will re-send, if there is a collision detected. Such operation will reduce the real time property greatly.

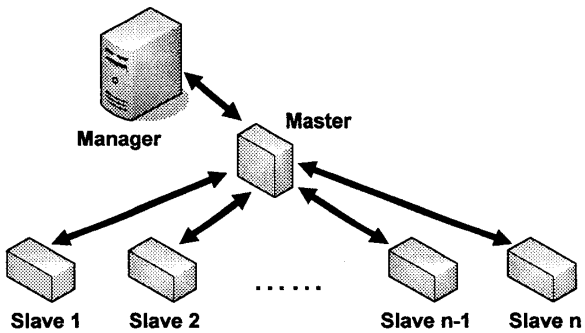

Fig.1 A Basic System Structure

In order to obtain both reliability and real time property, it is necessary to create a mechanism to control the transmitting timing for each slave. Here we use an infrared communication for a down-link, a RF communication for a up-link between master device and slave devices. Fig.2 illustrates the packet format transmitted from the master device and the RF packet format transmitted from slave to master. The data for every slave are included in the packet, but the order of the data can not be fixed.

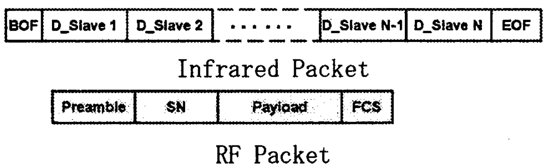

Fig.2 Infrared and FR Packet Format

Although all slave devices receive all infrared signal transmitted from the master device, but each slave takes the data for it only and triggers RF transmitting using the timing information provided by the data.

Because the RF transmitting operation will be synchronized with the infrared signal, all the slaves can share the same channel without any possibility of collision. Fig.3 illustrates the hybrid communication sequence. From Fig.3, it is easy to know that RF packets are transmitted at different timings, which don't overlap each other.

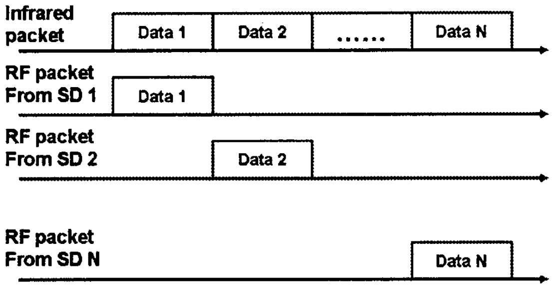

Fig.3 Infrared and RF Traffic Sequence

A unique ID is allocated to each slave device to distinguish them. This ID is also used for identifying the time slot position for each slave. To simply process, a fixed packet length is defined.

To guarantee that any communication can be detected, CRC approach is used for both infrared packet and RF packet transmitting. Also the data transmitted from master will be resent back to master as parts of ACK information. For a one infrared packet, there is only one byte for each slave, some commands or parameters will be send to slave in a sequence.

3. IMPLEMENTATION AND EXPERIMENT

In order to confirm the performance of the protocols and system we presented, we implement the protocol in a MSP430 environment. We have been able to demonstrate a 115 Kbps Infrared transmission and a 2Mbps RF transmission on platform of TI MSP430 microcontroller. In our implementation, up to 255 slave devices can be connected with the master device simultaneously.

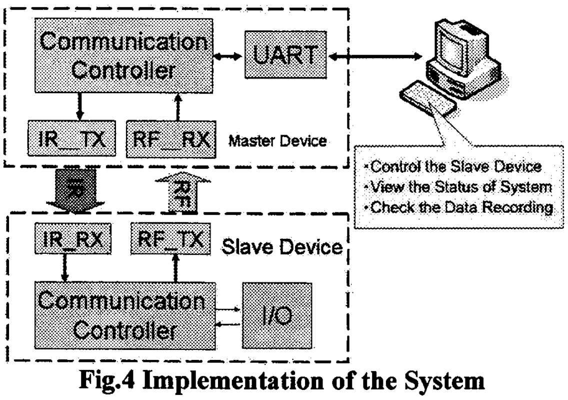

Fig.4 Implementation of the System

The main function in this version is as followings: 1) Send command to the slave for initial setup, operation mode change, data display; 2) get the condition from each slave device; 3) a full confirmation for communication. Fig 4 illustrates the system block

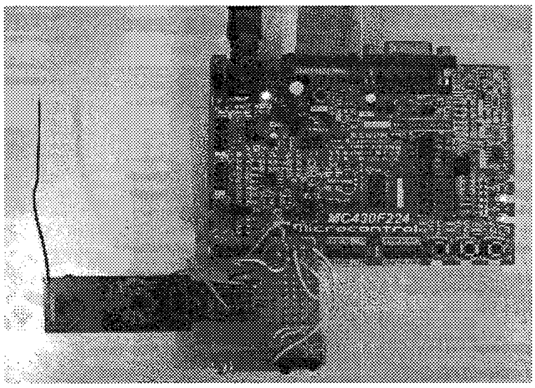

Fig.5 Slave Device

Fig.5 shows the photo of the board for slave. In slave side, there are one key for input and three LED for showing the condition or operation mode.

The communication cycle time for 255 is 22.6ms, and the RF communication period for each slave is 0.033ms which is less than 0.087ms, the infrared time for every slave. The cycle speed is fast enough for normal PLC control.

With operation on a PC, we can change the mode of slave, or send parameters or command to the slave, or get input condition from slave. The response is quick as we expected. There is no collision detected.

4. CONCLUSION

The goal of our design is to provide an efficient wireless communication approach for e-factory environment. The approach must be reliance, low cost, and flexible in order to meet a wide range of application goals. Based on the experiment result, it is confirmed that the hybrid communication system can satisfy the above requirement. In next stages of the research, we will check the performance of the system in detail, and develop some interface based on Industry standard to connect the new system with the PLC system.

5. REFERENCES

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2. Infrared Data Association, Infrared Data Association Serial Infrared Physical Layer Specification, 2001