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# **A Real time ZigBee Based Locating System**

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*Abstract-Embedded Systems based on ARM processors are used extensively in mobile devices like PDA's and MP3 players.ARM is 32bit Reduced Instruction Set Computer(RISC).Windows CE is real time, multi-task operating system that works on a 32-bit processor. This paper suggests Windows CE embedded operating system, and how to build a platform for Windows CE operating system embedded in a LS5310 ARM11 microprocessor S3C6410 and also the design of Windows CE embedded applications based on Embedded VC++ 4.0. Here we are employing RS232 serial port of ARM 11 processor and ZigBee wireless data communications module to design an application for a ZigBee location system with an easy-to-use interface. It performs multiple functions like information and data receiving, saving, processing and display. It has advantages of high performance, low cost, and low power consumption and is an important component of the network locating system.*

*Keywords: ARM microprocessor, RISC, RS-232 , Windows CE, Embedded OS, ZigBee Locating System*

## **1. INTRODUCTION**

There may occur a situation where a worker like a fire fighter might be seriously injured or might be facing other difficulties where identifying the location is preliminary for providing necessary aid. With the development of information technology, ZigBee becomes a new wireless network with advantages of close quarters, low complexity, low power consumption and low cost. Connecting the Sensor equipments with the ZigBee locating system will provide information

about temperature, gas pressure and other real time information. By developing electronic technology, the chip manufacture to be lower cost and enhanced function, so that embedded microprocessor has become a mainstream of embedded system design. However, the only embedded microprocessor is not enough, but also need an embedded operating system platform on microprocessor. Embedded operating system is transplantable, can be running on different microprocessor, with little kernel spending, high efficiency, highly modular and expansibility. It can provide multi-task, multi-process, multi-thread, and support a variety of equipments, network, user interface. This design is a terminal equipment of ZigBee network locating system, that is based on 32-bit ARM11 microprocessor and Windows CE embedded operating system

## **2. FUNCTIONAL OVERVIEW OF EQUIPMENT**

Locating system consists of a wireless backbone network and moving targets, adding different location algorithm. According the actual environment position, ZigBee wireless location system uses ZigBee module form a network. Referenced nodes in the network receive information from target nodes (such as RSSI LQI) and send to central control mechanism for

processing. Moving targets use ZigBee module to be portable mobile devices. Sensors can be connected to form measurable and identifying mobile equipments. That can use IEEE802.15.4 wireless transmission to control module dormancy, awakening process.

When targets are moving, the estimated value of the moving location fluctuate. The fluctuation caused by RSSI or LQI irregular changes of the fixed nodes. The reasons may be noise in the same band, or approaching objects on the radio wave disturbance, or a sudden change in the direction of the antenna. Since randomness, it is not easy to eliminate completely, but we can use suitable algorithm to reduce estimated value fluctuations. Through proper calibration and measurement, this would reduce measurement error.

Figure 1 shows the basic structure of the design, 32-bit ARM11 microprocessor run on the Windows CE. Embedded microprocessor communicates with ZigBee modules by RS-232 and control LCD touch screen user interface. Fig1

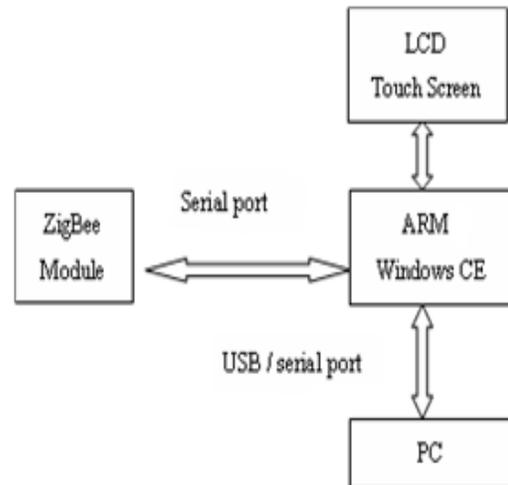


Fig 1 System Structure

#### 4. HARDWARE INTRODUCTION

##### A .Zigbee module Introduction

Helicomm Wireless Module, take 8 bits Silicon Laboratory 8051 and the Freescale SCM as two main axles, combined with Chipcon, Freescale ZMD and other IEEE802.15.4 RF chip. It is a complete sensor network embedded module integrated multi-function of transmission, communications and measure. SCM manage stack, the basic control and monitoring functions, while the RF chip mainly provide wireless communication interface accord with IEEE standard.

IP-Link122X Series module integrates with IEEE Standard 802.15.4 RF transceiver and the Silicon Lab's 8051 microprocessor. It has many kinds of antennas connection way and communication distance choice. We can set up network model as stellate, dendriform or reticulate. ZigBee-Ready IP-Net software protocol

embedded in module has serial communication function, allowing for RS232/RS485 data stream transmission through jump, thereby improve data reliability and increase the transmission area. Choose IP-Link1220 module to compose ZigBee network, the module structure shown in figure 2.

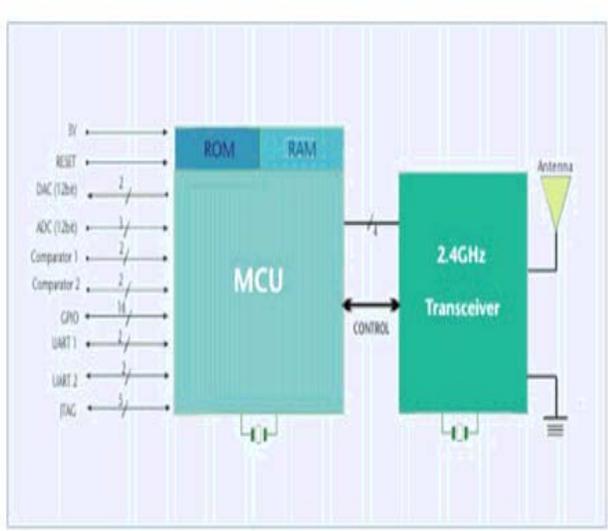


Fig 2 IP-Link1220 module structure

**B. ARM Development Board Introduction**

LS5310 is mainly composed of Samsung's S3C6410 32-bit microcontroller (ARM1176JZF-S) and 3.5 TFT-LCD touch screen. This suite has a piece of 256 M Byte DDRAM, 1 piece of 1 Giga Byte NAND Flash, entire performance MMU with advantages of high-performance, low power consumption, low cost, small size. In addition, it has 1 USB host, 1 USB device and 2 3-line serial port with a RS-232.DM9000AEP to expand a 10 or 100 Mbps Ethernet port, the system can

access the Internet. It is applied to portable intelligent terminal, man-machine contact and other fields.

**C. ARM and ZigBee Module Interface**

Establish serial communication between ARM microprocessor and ZigBee module. By wireless transmission model, RS-232 serial port can realize multipoint-to-multipoint or point-to-multipoint data transmission between equipments. NW-RS232 is a standard needle 9 (DB9) RS-232, the interface definition shown in figure 3.

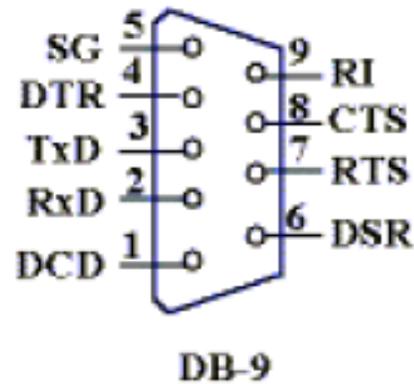


Fig 3 RS-232 interface definition

NW-RS232 occasions in both point-to-point and multi-point communication, such as these applications: communication between DTE and DCE; between DTE and DTE; among many DTE, between a DCE and many DTE, and between a DTE and many DCE, setting its own node and target node by AT order.

**4. SOFTWARE DESIGN**

**A. Windows CE Embedded Operation System**

Windows CE (WinCE) is a multi-task and real-time embedded operating system for 32 processors. It is compact, efficient and reducible, be applied to hardware resource-constrained systems. From the system point of view, WinCE is not merely an operating system, but also includes equipment support, system development kit, application development kit, integrated application procedure and so on. A WinCE system can be divided into four layers: hardware, hardware support, operating system and application. The hardware layer includes microprocessor and all peripheral equipment. Hardware support layer (BSP) provides interface between hardware and operating system. The operating system layer visit hardware through API provided by BSP. OS with WinCE components can customize to optimal performance. Application layer is user applications for embedded system development. WinCE has good real-time performance, high reliability, openness and good man-machine interface. Embedded system based on WinCE provides unified and expandable solution.

The special hardware durability and the PC flexibility unifies it together. Build a WinCE platform. First, customize WinCE according the hardware configuration, installation and device driver. Then produce operating system image document based on the target hardware. Through net card, serial or parallel port the mapping document can be down to the target hardware device. Building process shown in Figure 4.

After establish WinCE platform, the software development kit (SDK) should be provided to support the development of application, including WinCE components. We choose Platform Builder 4.2 for

operating system configuration, compile, create SDK, and import into Microsoft Embedded Visual C ++ 4.0, which provide tools to test and modify applications.

*B. Application Design*

The equipment's main function include: (1) Show map, communication with ZigBee module, through locating algorithm to display nodes (person). (2) Choose target nodes on user interface to observe. (3) Data interactive and Real -time update information.

The design mainly includes RS-232 serial communications with ZigBee module and user interface.

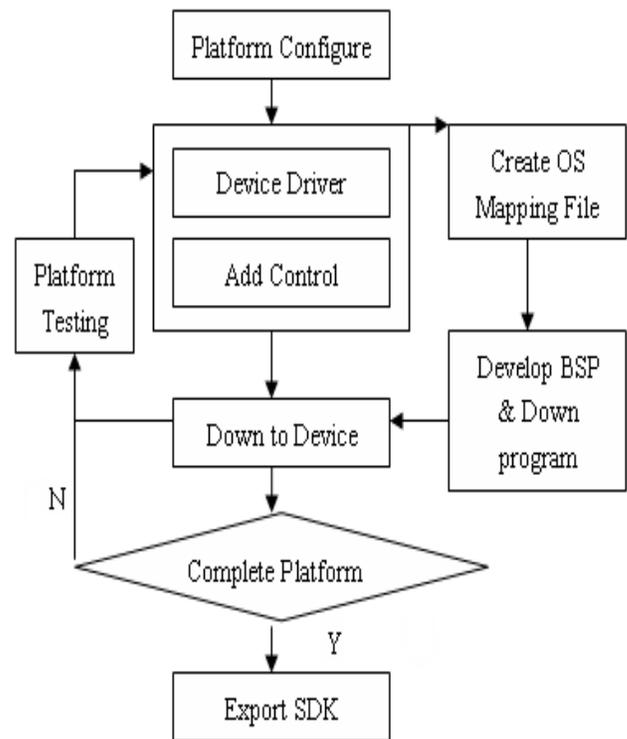


Fig 4 Windows CE platform building

Following briefly introduces application development in Embedded Visual C ++ 4.0.

1) *Serial Communication:*In WinCE, the task of reading and writing on serial port completes by file read-write function.

```
hSer = CreateFile (TEXT ("COM1:"),
GENERIC_READ | GENERIC_WRITE,0, NULL,
OPEN_EXISTING, 0, NULL);
```

```
//return a file handle such as close file handle, use
CloseHandle (hSer) to close a serial port.
```

```
//read data from serial port
```

```
rc = ReadFile(hSer, &ch, 1, &cBytes, NULL);
```

```
// write data to serial port
```

```
rc = WriteFile(hSer, &ch, 1, &cBytes, NULL);
```

```
// set serial port
```

```
BOOL SetCommState (HANDLE hFile, LPDCB
lpDCB);
```

```
BOOL GetCommState (HANDLE hFile, LPDCB
lpDCB);
```

```
// hFile is an opened serial port handle, lpDCB is a
pointer point to DCB structure
```

```
typedef struct _DCB
```

```
{
```

```
    DWORD DCBlength; //size of structure
```

```
    DWORD BaudRate; //baud rate
```

```
..... } DCB;
```

DCB is a structure including many serial port parameters. In general, first fill the DCB structure by GetCommState() modify some parameters then configure by SetCommState().

```
SetCommMask (hSer,EV_RXCHAR | EV_CTS |
EV_DSR | EV_RLSD);
```

```
While ( hSer != INVAIDE_HANDLE_VALUE )
```

```
{
    WaitCommEvent( hSer, &dwCommModemState,0
)
    //wait event
    if ( dwCommModemState & EV_RXCHAR )
    //get data and put into buffer
    {
        while ( dwBytes == 1 )
        ReadFile( hSer,&Byte,1,&dwBytes,0 );
    }
}
```

2) *User Interface Design:* Simple dialog as node choice and information display, add control such as check box, edit box, shown in figure 5. By BN\_CLICKED message to choose nodes, observe location of nodes and display information in the edit box.

Choose nodes and press "OK" to affirm, then the map showed with the location of node. Open bitmap and show in the view as following.



Fig 5 Information Select Dialog

Open bitmap and show in the view as following.

```
//In OnDraw (CDC* pDC) function
{
    CBmpseeDoc* pDoc = GetDocument();
    BITMAP BitMap; CDC DCMem;
    ASSERT_VALID(pDoc);
    if (!pDoc->GetHandle()) return;
    //create memory device
    DCMem.CreateCompatibleDC(pDC);
    pDoc->SelectBitmap(&DCMem);
    pDoc->GetBitmap(&BitMap);
    //copy bitmap to the show device
    pDC->BitBlt(0,0,BitMap.bmWidth,
    BitMap.bmHeight, &DCMem, 0, 0, SRCCOPY)
    pDoc->SelectOldBitmap(&DCMem);
    //draw nodes on the map
```

```
pDC->SelectObject (&RedBrush);
pDC->Rectangle(&mrect);
}
Update data by timer's ON_WM_TIMER
SetTimer(1,1000,NULL);
//open timer 1
In OnTimer(UINT nIDEvent) function
{
    CScrollView::OnTimer(nIDEvent);
    //refresh data timely
    .... Invalidate(); //refresh screen
}
```

## 5. CONCLUSION

This paper introduces design and implementation of a simple application terminal unit for a real-time ZigBee network locating system. It is based on ARM11 microprocessor and Windows CE embedded operating system. Use LS5310E suit with S3C6410 (ARM1176JZF-S) microprocessor, which is high performance, low power consumption and low cost. Under WinCE, we have performed serial communication between ARM and ZigBee module and developed user interface application. The software design is standardized, orderly and real time. With friendly user interface and simple operation this will be an useful mobile equipment in the ZigBee network locating system.

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