A Design of Embedded Terminal Unit Based on ARM and Windows CE

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Abstract: Embedded system based on ARM has been widely used in many different fields. Windows CE is a real-time, multi-task operating system on 32-bit embedded processor. This paper introduced Windows CE embedded operating system, and how to build a platform for Windows CE embedded in a ARM9 microprocessor S3C2410, and also the design of Windows CE embedded applications. Based on ARM microprocessor and Windows CE operating system, using RS-232 serial port and ZigBee wireless data communications module, designed a terminal unit for the ZigBee wireless network locating system, with a friendly user interface. It can realize functions including: the information and data receiving, saving, processing and display, has advantages of high performance, low cost, and low power consumption, is an important component of the network locating system.

Keywords: ARM microprocessor, Windows CE, Embedded, ZigBee, Locating System

1 Introduction

Mining accidents often happen in China. If underground miners locating comes true, we would use area locating technology to hold miners' position. Connecting the sensor equipment accompanied by miners and giving real-time reporting of gas concentration in the area or other related information, that would be helpful to reduce the occurrence of accidents. 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. It applies in intelligent home, security protection and test systems.

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 ARM9 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 ARM9 microprocessor run on the Windows CE. Embedded microprocessor communicates with ZigBee modules by RS-232 and control LCD touch screen user interface.
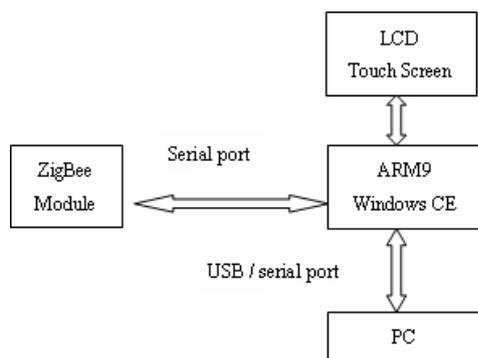

Fig1 System structure

3   Hardware Introduction

A. ZigBee Module Introduction

Helicomm Wireless Module, take 8 bits Silicon Laboratory8051 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.
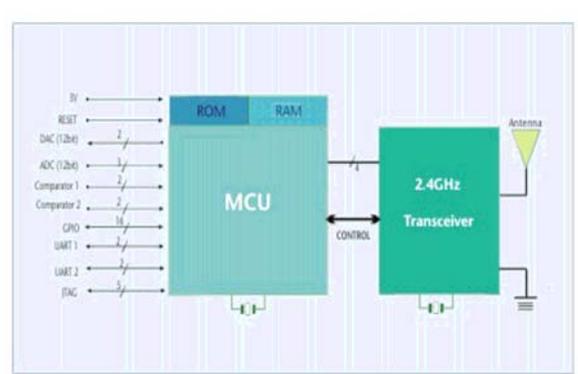

Fig 2   IP-Link1220 module structure

B. ARM Development Board Introduction

QT2410E is mainly composed of Samsung's S3C2410 32-bit microcontroller (ARM920T) and 3.5 TFT-LCD touch screen. This suite has 2 piece of 32M Byte SDRAM, 1 piece of 64M Byte NAND Flash, entire performance MMU, 16KB instruction caches and 16KB data caches, with advantages of high-performance, low power consumption, low cost, small size. In addition, it has 1 USB host, 1 USB device and 3 serial port. CS8900A to expand a 10 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
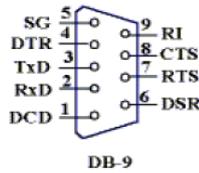
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definition shown in figure 3.

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 in 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.
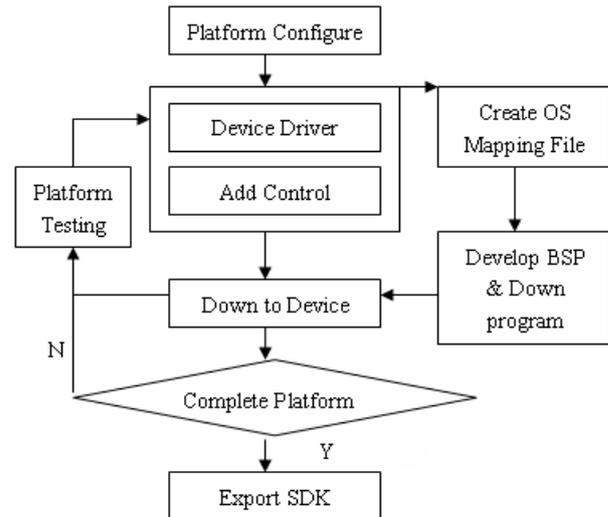

Fig4   Windows CE platform building

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 mine road map, communication with ZigBee module, through locating algorithm to display nodes (miners). (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. 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

    A 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

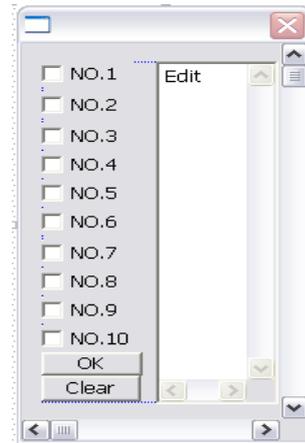information in the edit box.

Fig 5   Information Select Dialog

    Choose nodes and press "OK" to affirm, then the mine map showed with the location of node. 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 terminal unit for ZigBee network locating system. It bases on ARM9 microprocessor and Windows CE embedded operating system. Use QT2410E suit with S3C2410 (ARM920T) microprocessor, which is high performance, low power consumption and low cost. Under WinCE, we have realized serial communication between ARM and ZigBee module, developed user interface application. The software design is standardized, orderly and real time.   With friendly user interface, simple operation and well interaction, this will be an useful portable terminal equipment in the ZigBee network locating system .

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Author Biography

Jiang Min, was born in 1984, is a graduate students, mainly study in digital signal processing, embedded technology.