Real-time industrial process controlling using LPC2148

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Abstract—In this abstract we are going to introduce an intelligent system for the industrial sector which is based on distributed embedded system. Distributed Embedded System employs various devices to provide various services with an application oriented program. To reduce the complexity of the methodology and engineering practices, Service oriented computing technique has been used in distributed embedded system to implement the service in Vx Works. This paper explains how to reduce the latency of industrial process plant which sometimes get overrun and leads to imperfection and disasters in the large scale industries and plant. Considering the threshold value for the parameters controlling plant process, the microcontroller need to maintain the values of the particular parameters below the threshold level to keep the working environment better for the plant process. Vx Works scheduling algorithm, earliest deadline first algorithm assigns priorities for the critical process parameters. With the credits of single-board and low price, lpc2148 acts as the most appropriate microcontroller for maintaining the continuous flow of bitwise address and word processing complementing to the Vx Works, which can cross-compile the programming data with eclipse IDE.

Index Terms—Vx Works, lpc2148, Distributed embedded system, eclipse IDE.

I. INTRODUCTION

For an intelligent system, maintenance engineering uses different engineering tools and equipment in the hardware platform to expertise its performance as the advance version of hardware brings to low processing speed and supports to lot more software platforms. In the ancient years, manual observation was a source in every industrial or plant process declarations which lead to a huge man power acquisition. But engineering concepts can not only help reducing the man power but also optimize the environment with equipment handling procedures and lesser the departmental budgets for maintainability, reliability and availability of equipment. In the recent time of industrial revolution expectations are for the most perfect result with reduced work load and automated monitoring and control.

Here, distributed embedded real time system works on the basis of service oriented computing where different working system and hardware parts are combined together to provide an application where a set of tasks are going to be prioritized based on the critical situations. It is a platform independent automatic system which schedules its tasks on earliest deadline first algorithm, where the task are monitored in a sequential manner but the priority is assigned to the task with shorter deadline, as the critical condition rule follows at the real time operating systems. The proposed system has features such as the service identification is done in the distributed real time systems [1].

This project intend to control and maintain the plant threshold parameters using LPC2148 by scheduling the tasks on real time operating system Vx works.LPC2148 is a NXP semiconductor micro controller which is based on 64 bit to 32 bit ARM-TDMIS processor with real time emulation and embedded trace support with speed flash memory of 32 KB to 512 KB. It memory interfacing width is 128 bit wide which helps in 32 bit code execution in maximum clock rate. It is best suited for communication gateways and application access control operation due to its serial communication interfaces which ranges from USB 2.0 full speed device, multiple UARTs, SPI, SSP, I2C and on-chip SRAM of 8 KB to 40 KB. LPC2148 is also suitably preferred for industrial controlling functions due to the functional nature of various 32 bit timers, single or dual 10 bit ADC and DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins.

Vx works, a real time operating system developed by Wind River System is specially designed to be used in embedded systems which uses eclipse based workbench IDE which makes it to support more number of programming platforms. In the hard real time integrated distributed systems hierarchy scheduling has more benefits which gives clear run time for time domain application scheduling. Here, modeling, verification and preemptive scheduling of task with priorities are scheduled [5].

II. SYSTEM MODEL

The system model of industrial process controlling and maintenance is divided into two sections. The first section comprises of transmitter section and the second one is receiver section. The system model is shown in fig. 1.

The transmitter section consists of all the sensors which are used to sense the control process environment for quality processing. In any industrial or plant process three parameters plays a vital role in maintenance, those are temperature, pressure, and ph. Here, we have included the level sensing technology also because it is an important aspect in the companies which deals with liquid product manufacturing or if it needs to maintain a certain amount of liquid level for well functioning of the process. So, in this project we use the microcontroller lpc2148 to collect the parameter sensing data and tally or adjust the parameters in their threshold value for stabilized processing of the plant functions. In order to control and maintain the threshold value, in our project

we have used the cooling fan for bring the temperature value below threshold value when it goes high. Similarly, solenoids switch for releasing the pressure and pumping motor for level monitoring. Here, the controlling tasks will be scheduled by Vx works depending on the priority criteria which we will assign during the channel interfacing to the controller. The transmitter section will transmit the maintenance values over the ZIGBEE.

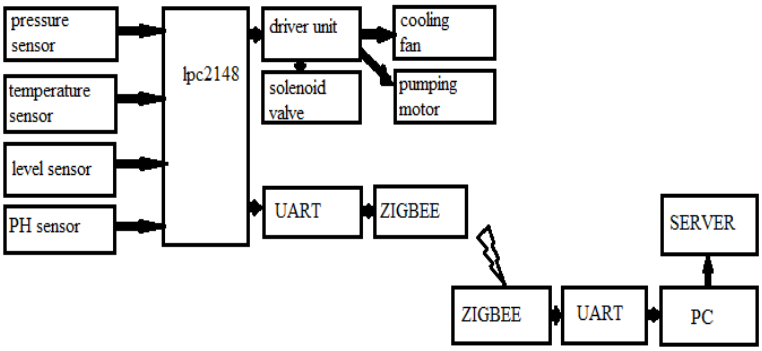

Fig. 1 System model of industrial process controlling

The receiver section receives data, which was been transmitted over the ZIGBEE and uploads the maintenance values into a server, so that company authorities get a clear and effortless updates of the parameters from processing area. The communication protocol used over the transmission is sensor media access protocol which is a non beacon enabled network where a channel without slot is used for the access mechanism of the ZIGBEE transmission to keep the receiver continuously active.

III. IMPLEMENTATION METHODOLOGY

For Capability to gather data from the sensors to perform the controlling actions by scheduling the tasks depending upon its priorities in real time we need to configure the sensors and microcontroller and also have to interface the controlling and environment sensing devices to lpc2148 through PC using KEIL. But for scheduling lpc2148 needs to be prepared with the required RTOS that is Vx works. Then Connection of ZIGBEE using UART needs to be done to the lpc2148 on the transmitter section in order to transmit the recorded maintenance data. At last for viewing the recorded data to the official administrators in the receiver section the data is received and through PC the recordings are been updated into the company server for further references.

A. Interfacing and configuring the hardware devices to lpc2148

There are many different types of boards available in market for lpc2148 but we need to choose the board visualizing the hardware devices we are going to interface and number of ports that we need to use for transmission and receiving purpose. The pins in lpc2148 are already defined for the various purpose its going to use. We have to read the datasheet provided with the board and need to interface the sensing devices to the pins which are defined for pulse width modulation. The output signals which are to be given to the driver unit should be interfaced with the analog to digital conversion pins. Here, we use relay to connect the controlling devices because they might be needed to turn on at same time. Driver unit is to boost up the signal. The ZIGBEE interfacing is also done at the same time. To bring the devices and the microcontroller into action the configuring is done by using KEIL. We develop a coding for the hardware devices interfacing, run and debug the coding and dump the hexadecimal file to lpc2148 using flash magic.

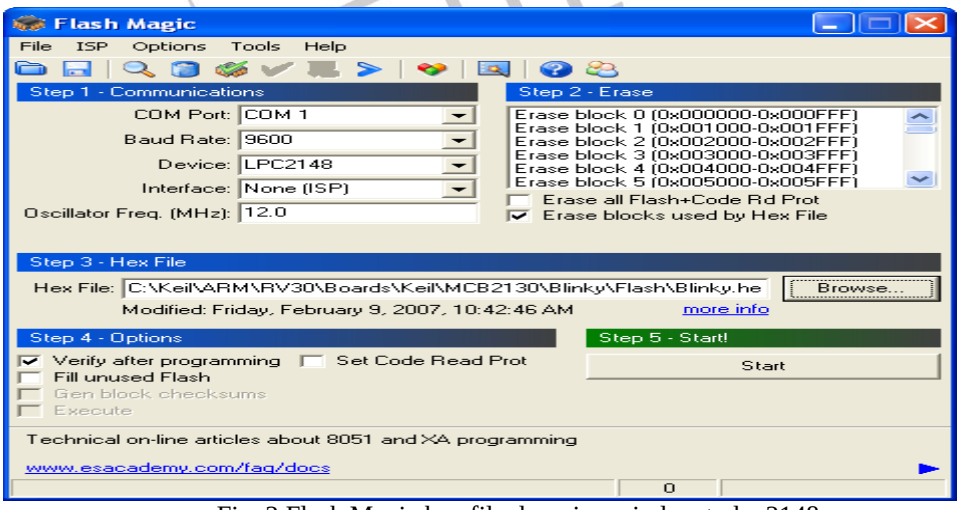

Fig. 2 Flash Magic hex file dumping window to lpc2148

B. Installation of Vx works on lpc2148 using JTAG

As Vx works uses eclipse integrated development environment which is when used in real time application needs a java run time environment to perform the task scheduling. So, we go for a step-wise procedure of installing eclipse integrated environment

where in we obtain java run time environment and simultaneously we install eclipse c/c++ development environment and update eclipse for cross development debugging through JTAG.

For opening and using Vx works for carrying out the programmed project, we need to open the project and do the important configuration settings. For ROM initialization we need to disable the interrupts, initialize the stacks, clear the cache and branch to ROM start. For initializing the system to boot we need to do the following steps

ROM start( )

Copy text segment, if not ROM based, to RAM. After copying the data segment to RAM if the message pops up that zero unused memory then we need to decompress ROM image if compressed.

For user configurations, the commands are

UsrInit( ) – first Vx works code

This code initialize caches, leave them in safe state, enabled. Zero the BSS segment and initialize interrupt vectors.

SyshHwInit( )

Resets and disable the hardware interrupts.

UsrRoot( ) – this is system root task.

Next we need to initialize I/O channels and fix priorities, install drivers.

MemInit( ) – initialize the memory

SysHwInit2

Then we need to do ant other further hardware initialization connect interrupts an have to enable desired interrupts for functioning.

Once the settings are over, we will build the project which we have programmed for the microcontroller, debug the program and then terminate it.

C. Tornado installation

After the installation of Vx works on lpc2148, we go for the installation of tornado software which will help us to understand and show the executable output of the project. The steps which are involved in the installation process of tornado are

1. Setting up the windows PC with correct patches
2. Finding out the installation key which will be required during the installation of tornado core CD and from BSP CD. Where in each of them has its own key which must be loaded to the directory.
3. We have to select a user account to use the installation.
4. After running the setup program the program requires an installation key and much other information about the host which is used to install tornado or the floating license server.
5. After all the configurations including manual steps completes the setup program an later an optional code may be required for some further installations.

Once the installation of tornado is over we can easily visualize the algorithms by which it is scheduling the task and using the algorithms for task management.

D. Configuration for ZIGBEE transmission

In the industrial management process we are going to transmit the maintenance data over the ZIGBEE which will transmit the working environmental parameter to the receiving section to update into the server. So for the ZIGBEE to work purposefully into the process we need to configure the ZIGBEE. There are various steps involved in it, the first step starts with the download and installation of the X-CTU software. The second step is to download and install the USB drivers so that whenever we connect the device to PC it gets detected automatically. Basically it is a process of plug and play. This driver installation involves USB driver and virtual COM port driver installation. The third step to process with the communication is to configure the RF module where the serial port adapter is assigned and we have to verify the baud rate and data settings assigned. Then we have to add the destination address and provide it with an encryption key. To direct the message to a particular node we have to set the destination address low/high to source address low/high of that node. Further we have to go for a run range test for checking ZIGBEE transmission and reception. At last we have to explore advance configurations to choose modem type and ZIGBEE router API, configure remote modules for sleep and manage RF network gateways.

E. Develop the virtual basic code showing the environmental parameters

Using the virtual basic.net a window has been created in order to check the availability of recorded environmental parameter ranged which were been recorded by lpc2148. This is the initial stage to check whether the data recorded are relevant or not. Later on this are the values which will be copied to the server for the further official readings by the control room. This page also shows the parameter which is in critical stage and the task which is scheduled first.

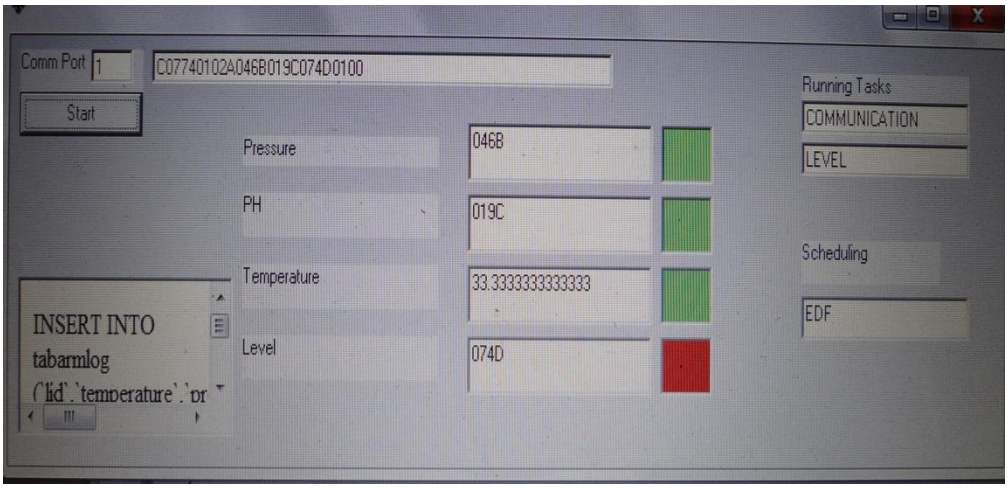

Fig. 3 Virtual basic page development to show parameters and scheduling

Once we select the port for the data cable connection and click on the start button the values are been continuously updates into the page and the parameter which shows a red signal is in critical situation and needs to be scheduled first according to the priority assigned by Vx works using the earliest deadline first scheduling technique. This page gives an idea that lpc2148 is performing its tasks well based on the configuration and installation made to run the process.

F. Developing a database stack in to the server and developing html page

We have tested that the process is working perfectly and now for further references the data is to be updated into the server. For storing the data into the server we need to specify the database stack to be used for this purpose. To update the data we need to utilize the SQL tools. The data is to be updated using the administration PC. For creating a new database we need to go to SQL database management and create a new database with a new table and have to valuate the columns and rows to be shown on the page and assign a domain name for the html page which is going to publish the data in future. The html page is created using PHP coding which will provide a page layout and web designing tools to make the page attractive.

IV. RESULTS

Lpc2148 is well capable of in maintenance of an intelligent system for industrial and plant process. We successfully control the environmental conditions and keep the parameters in their desired threshold values. Service oriented task computing is performed by the Vx works. Well established communication module ZIGBEE plays a main role in sending the data over the communication channel for update of data into the server. In the browser when we go for the specified page in the server link we are able to see the time to time update of the parameter levels with specific log date and time.

Fig. 4html page showing server updates

V. CONCLUSION

In this phase of the project, a secure intelligent system for environment maintenance and controlling in distributed system has been successfully developed with the help of Vx works the tasks are been scheduled. Using ZIGBEE SMAC protocol with X-CTU

software the data recorded were successfully transmitted and received by configured ZIGBEE which is then connected through an USB cable to the administrative PC to update the environment condition into the server. Visual basic and PHP program coding played a important role with SQL to avail the parameter to a remote sub station or control room.

In the future work phase, the main focus can be to working in a wider range wireless network with the lpc2148 having features to configure itself with the available connections in its range. Other different parameter measurements can also be added into the manual for perfect industrial outlet. The efficiency of this embedded system can be improved by providing flexibility to the user to choose between different wireless connections and providing an inbuilt sensing equipment devices with the controller.

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