Design in Real time systems course

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Abstract

This paper describes the design topics and projects done in a course titled " Real time Systems". The advancements in technology is taken into account in this course. This course emphasizes hard and soft real time computer system design for a single processor embedded system applications and distributed real time systems. Topics covered include characterizing real-time systems, performance measure, task assigning, scheduling, Fault tolerant scheduling, run-time error handling, run-time support, compiler, linker, debugger, kernel, real time databases, real-time communication, software development techniques; practical applications.

Introduction

Real time embedded microcomputer systems are found in almost every thing from kitchen appliances to automobiles and aircrafts. Systematic study of real time characteristics, methods to test the design by simulation and in the actual situation for meeting the real time constraints, introducing graceful degradation in performance where applicable are becoming important. The field of real time computing covers the areas in computer architecture, embedded microprocessor system design, system simulation, fault tolerant computing and real time operating system (task scheduling etc). A real time engineer has to design the RT system to meet the execution time restriction under varying conditions.

A list of books and web references used in this course are given in the reference.

The course topics are listed below and the time spent on these topics.

1) Introduction and Basic concepts (1 hr)
2) Characterization of Real time systems and Tasks (2hr)
3) Task Assignments and Scheduling (3 hr)
4) Programming Languages and tools

C, ADA, Real time Java, Matlab Real Time Tool Box (6hrs)
5) Real time Operating Systems
    Win CE, Real time Linux
    Wind River RTOS, QNX
    UC/OS II real time kernal (8 hrs)
6) Real time Communications (4 hrs)
    Mobile Protocols
    Bluetooth
7) Real time databases – quick review (2 hr)
8) Distributed real time systems (4 hours)
9) Run Time monitoring- quick review (1 hr)
10) Fault Tolerance (1hr)
11) Reliability evaluation techniques (1hr)
12) Clock synchronization (1hr)
13) Real time DSP System
    Code composer Studio
    Development Platform (6 hrs)

14) Real Time System Development for PDA / hand held devices
    Code Warrior software
    ELAN 104- development board (5 hrs)
15) Automotive Applications (4 hr)

Presentation:

A number of papers were assigned for reading. Each student had to make one presentation on one of the topics during the term.

Lab type Assignments:

The students worked on a number of laboratory assignments which include the following: Real Time Java, Use of CodeWarrior for Palm OS and Linux, Use of Real Time Matlab tool, Use of UC/OS II, DSP System, and HC 12 system

Project:

Each student worked on a term project during the second half of the course. Details of the term project are made available in the course web.

Some of the projects done during the second half of the course are listed below.

- Simple rate monotonic scheduling kernel on Motorola 68HC 12 processor using micro OS
- RMS scheduling using RT Linux
- Hard real time demo with dynamic task priority changes.
- Embedding RT Linux
- Lab view and RT Linux interface

- Robot control using RT Linux
- RT Linux for GPS receiver
- Using RT Linux in safety critical applications
- Matlab, Simulink, Real time workshop tool interface

Windows CE Development Kit

Windows CE is a popular real time operating system for applications like PDA, palm computers and small control appliances. To experiment with Windows CE, we used the kit from Arcom [14]. This development kit is based on an intel 386 board with a real time multi tasking operating system, 1 Mbyte on-board Flash. It comes with a small code size , high performance TCP/IP base protocol designed for embedded system and has been configured for use on the 10 base T Ethernet port of SBC-386 EX. Students use this development kit to develop a simple application using C++ language.

OSEX/VDX

Extensive amount of time is spent by (embedded) Software Engineers to develop and debug software for the operating system (OS), network communication, network management, and input/output [11]. OSEK/VDX standards were originally developed for the automotive industry and to describe a small, real-time OS ideal for most embedded systems that are statically defined. Dynamic loading of tasks is not supported. These specifications are becoming standards by International Standards Organization(ISO 17356). Students learn about this standard as part of this course.

RT Linux:

RT Linux is a **hard real time** operating system that handles time –critical tasks and runs Linux as its lowest priority execution thread. This allows the system to run accurately timed applications to perform data acquisition, system control and robotics, while serving as a standard Linux workstation. At one-time, real-time operating systems were primitive, simple executives that did little more than offer a library of routines. But real-time applications today now require access to TCP/IP, graphical display and windowing systems, file and database systems, and other advanced features. RT Linux uses a virtual machine layer to make the standard non-real time kernel fully pre-emptable.

Students install RT Linux on a PC and demonstrate Rate Monotonic Scheduling using RT Linux.

Conclusion:

In this paper we describe the design topics and projects done in a course titled " Real time Systems". The advanced technology like PDA. Bluetooth communication, Windows CE etc are taken into account in this course. This course emphasizes hard and soft real time computer system design for a single processor embedded system applications and distributed real time systems. Since the real-time systems technology is changing fast, the topics covered on applications will change each semester. But the basic topics which

include characterizing real-time systems, performance measure, task assigning, scheduling, Fault tolerant scheduling, run-time error handling, run-time support, compiler, linker, debugger, kernel, real time databases, real-time communication, software development techniques etc do not change.

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Biography

DR. SUBRAMANIAM GANESAN, is a Professor in the department of Computer Science and Engineering, and Associate Director of Product Development and Manufacutring Center Oakland University, Rochester, MI 48309, USA He is working on automotive applications like: DSP based electric power steering, Fuzzy idle-speed control, road scene analysis for intelligent vehicles, real time lossless Image compression, mobile communication protocol, application of wavelet transform and Hough Transform . More details about him can be obtained from the web address:
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Page 7.367.5

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