SE-631

Real-Time Systems Design and Implementation

Spring 2009
Location: HH 524
Time: T 4:30PM – 7:15PM

Instructor

- Jiacun Wang
- email: jwang@monmouth.edu
- Office: HH B-12
- Office Phone: (732)571-4449

- Office Hours: Tuesday 2:00 – 4:00 PM. Other time by appointment

Course Objectives

Real-time systems are systems which must produce their results within specified time intervals. Examples of real-time systems are flight control programs, air traffic control systems, control systems for nuclear power plants, patient monitoring systems, military command and control systems, and telecommunication systems. Real-time systems are playing a more and more important role in our daily life. Even our safety depends on their correctness.

The objectives of this course are manifold: (i) to understand fundamentals of real-time and embedded software technology, (ii) to get familiar with a broad view of issues in real-time software design and implementation, (iii) to get familiar with the mechanisms for inter-process communication, synchronization, and their implementation techniques, (iv) to get exposed in the use of structured methods for analysis and specification of real-time software, and (v) to develop application software in the real-time laboratory.

Textbook

No textbook. Course material will be distributed in the class.

Laboratory

Laboratory equipment is designed and assembled around several commercially available software and hardware components. The major hardware/software components are: personal computer workstations (PCWs) hosting Tornado integrated software tool for development of real-time and embedded software, Motorola single board computers (SBCs) hosting VxWorks real-time operating system, and a hardware railroad model (RR) assembled from components manufactured by Märklin company.

Application software is developed, debugged, and tested in Tornado environment, which simulates the target environment, i.e. where the code will finally execute. Tornado executes on Windows NT hosted by PCW. The real-time operating system VxWorks hosted on SBC provides a native environment for application software. The RR is pure hardware with no notion of a software program. The connection of SBC to PCW enables application software developed in Tornado environment to be downloaded to SBC and executed in the native environment of VxWorks. Finally, by connecting RR to SBC, application software for real-time control of the RR can be downloaded to SBC. Application software controls RR via an

application-programming interface (API) that utilizes RR hardware components. All Tornados have their own SBC and access to the same demonstration target - the railroad model.

Laboratory manuals can be found in the lab (E153B) or on the Web. All lab PCWs, hosting Tornado, have dual Internet cards, where one is used to have on-line access to Tornado manuals from the Wind River company at http://www.wrs.com. The following hardcopy manuals are available in the lab:

- Tornado User's Guide, Wind River Systems, 1999
- VxWorks Programmer's Guide - 5.4, Wind River Systems, 1999
- VxWorks Reference Manual - 5.5, Wind River Systems, 1999
- Tornado BSP Developer's Kit for VxWorks, Wind River Systems, 1999

Course Work

There will be seven lab assignments and a research project.

The first four lab assignments are targeted at gaining hands-on experience in multitasking and inter-task communication via: shared memory, semaphores, messages queues, pipes, and interrupts. The last two assignments utilize the real-time controlled railroad model.

The research project is designed for students to get some knowledge on the latest advances in the real-time design and development. Students are required to select articles from a given list of journals and give a PowerPoint presentation on what issues the articles address, how the authors resolve the issues, what are the advantages and drawbacks of the presented algorithms or methodologies in the articles.

Grading

Lab Assignments	70%
Final Exam	30%

Class Participation

Class participation is strongly recommended. If you miss a class, it is your responsibility to find out what is covered and what announcements are made in the class.

Withdrawal

Last date to withdraw with automatic assignment of a "W" grade: Monday, March 30, 2009.

Academic Honesty

Everything you turn in for grading must be your own work. Academic dishonesty subverts the University's mission and undermines the student's intellectual growth. Therefore, we will not tolerate violations of the code of academic honesty. Penalties for such violations include suspension or dismissal and are elaborated upon in the Student Handbook.

Special Accommodations

Students with disabilities who need special accommodations for this class are encouraged to meet with the instructor or the appropriate disability service provider on campus as soon as possible. In order to receive accommodations, students must be registered with the appropriate disability service provider as set forth in the student handbook and must follow the University procedure for self-disclosure, which is stated in the University Guide to Services and Accommodations for Students with Disabilities. Students will not be afforded special accommodations for academic work done prior to completion of the documentation process with the appropriate disability service office.

Tentative Course Contents

- Introduction to Real-Time Systems and Laboratory
- Real-Time Programming
- VxWorks Real-Time Operating System
- Tornado: Integrated Real-Time Software Development Tool
- Multi-processes Synchronization and Communication
- Resource Control
- Real-Time Facilities
- Real-Time Scheduling
- Marklin Railroad Model
- Reliability and Fault Tolerance

- Lab Presentation and Project Presentation