System Development Process based on Embedded Linux and Sensor Node

Shin-Hyeong Choi[1*] and Hyoung-Keun Park[2]

[1] Dept. of Control & Instrumentation Engineering, Kangwon National University, 1 Joongang-ro Samcheok-si, Gangwon-do, South Korea*
[2] Dept. of Electronic Engineering, Namseoul University, 91 Daehak-ro Seonghwan-eup Sebuk-gu Cheonan-si, Chungcheongnam-do, South Korea
cshinh@kangwon.ac.kr, phk315@nsu.ac.kr

Abstract

Embedded systems are suitable for application system with strict requirements on the functionality, reliability, cost, size and power consumption Also embedded Linux has been widely used to its numerous characteristics, such as open-source, small size, fast speed, and excellent network performance. Therefore, embedded Linux gets more attention and has more application in industrial monitoring field. In this paper, we propose system development process based on embedded Linux. Using this system development process can increase the reusability of development process and time.

Keywords: *Development Process, Embedded Linux, Sensor Node*

1. Introduction

In recent years, a new variety of applications using Internet or smart phone are beginning to emerge. Methods to collect data from around also have been presented. In addition, by the fast performance, optimization and miniaturization technology of hardware, sensors that collect environmental information from around have been miniaturized. And there are a lot of monitoring programs using sensor. To collect and analyze data sent from various sensors, PC server is used previously. But recently, embedded systems are usually used. Due to high performance and optimization techniques, now embedded systems can also run many programs that work on server. Though there are many advantages, system development on embedded systems are more difficult than on a PC.

In this paper, we present system development process based on embedded Linux and sensor node.

The rest of this paper is organized as follows. In section 2, we describe characteristics of embedded Linux, wireless sensor networks and framework concept. In section 3, we introduce system development process based on embedded Linux. Last section is conclusion.

2. Related Work

In this section we describe characteristics of embedded Linux and wireless sensor network technology.

2.1 Embedded Linux

Embedded systems are typically designed for a specific application or purpose and come in a variety of shapes and sizes. Also embedded systems are resource constrained and have

power limitations [1, 2]. Therefore, embedded systems need slim and real-time operating system. Because of the numerous economic and technical benefits, embedded systems usually adopt embedded Linux as operating system. The Linux kernel sources are well structured such that CPU-specific code is easy to find and is minimized. As a result, Linux can be made to run on almost any CPU board. So, embedded Linux may be the best choice for a particular embedded system. In other words, embedded Linux system simply designates an embedded system based on the Linux kernel and does not imply the use of any specific library or user tools with this kernel [3].

2.2 wireless Sensor Network

Sensor networks are the key to gather the information needed by smart environments, whether in buildings, utilities, industrial, home, or elsewhere. Wireless sensor networks provide sensing information and process this information. Wireless sensor networks compose of many sensing nodes [4, 5]. Sensor node consists of one or more microcontrollers, CPUs or DSP chips and has multiple types of memory, a RF transceiver and a power source such as battery. Also sensor nodes accommodate various sensors and actuators. Hence, wireless sensor networks can be used to provide environmental information and a promising platform for supporting environmental monitoring.

3. System Development Process

The development of embedded systems is done by separating the host and target. Application development is performed by the host and application execution takes place on the target. In addition, to collect and analyze in real time data sent from various sensors, a monitoring program is developed through interworking between embedded systems and wireless sensor network. In this paper, we present system development process for monitoring system based on embedded Linux. In general, monitoring system includes collecting, storing and processing of environmental data gathered with many sensor nodes. The overall architecture of embedded system and sensor node interworking system is shown in Figure 1. In this paper, embedded Linux is installed to embedded system and sensor node uses MSP430 as microprocessor, CC2420 RF Chip, sensor board and so on.

The monitoring system receives environmental data from wireless sensor nodes and then analyzes the environmental data. We analyzed a lot of use cases about monitoring system based on embedded Linux [5, 6, 7, 8].

As mentioned before, system development process for the monitoring system is based on both environments, such as development and runtime environment. The overall environment consists of host, target and wireless sensor networks. In the host, Linux as operating system, tool-chain as cross-compiler and TinyOS for wireless sensor node is installed. In the target, boot-loader for booting, kernel and file system as embedded Linux, DBMS for environmental data management and monitoring program as an application is installed. In wireless sensor nodes, sensing program as application is installed.

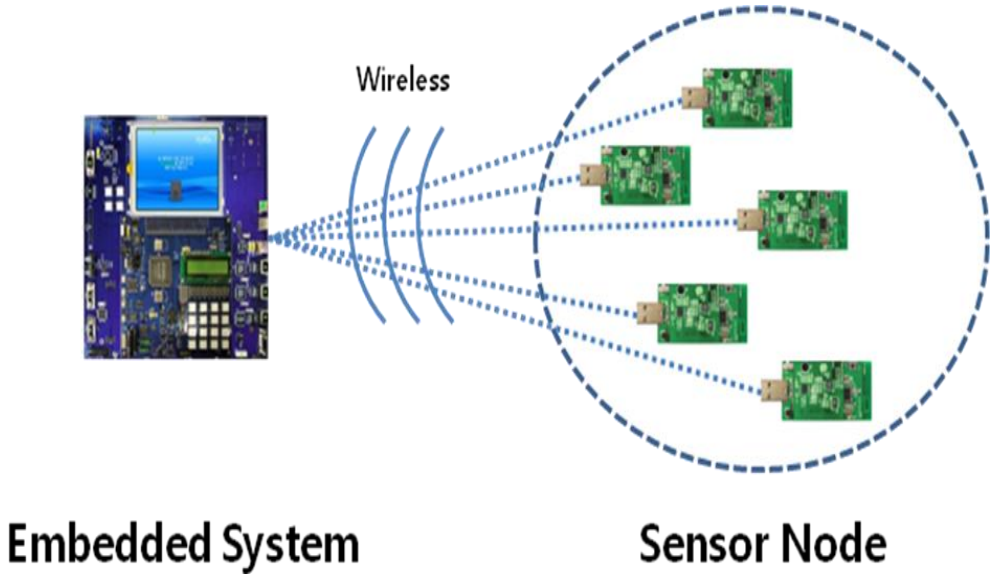

Figure 1. Architecture of Embedded System and Sensor Node Interworking System

The development process of monitoring system mainly consists of three parts which are host, embedded system and sensor node, as shown in Figure 2.

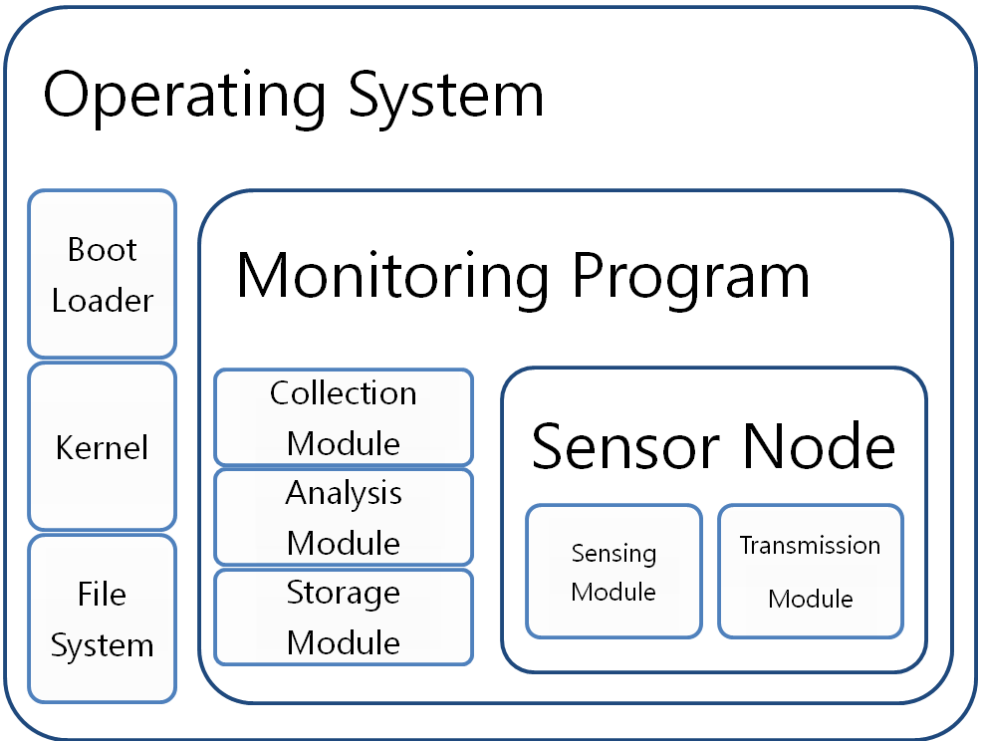

Figure 2. Three Part of Development

1) The software structure of host part includes Linux OS, tool chain for embedded systems and TinyOS for sensor node. This software performs development process of the entire system.
2) The software structure of embedded system part mainly includes RTOS, DBMS and monitoring program. In RTOS, boot-loader, kernel and file system are installed as element of embedded OS. And embedded DBMS is installed for environmental data management. Monitoring program consists of collection, analysis and storage module.
3) The software of wireless sensor node consists of sensing module and transmission module. Sensing module collects environmental data from sensor node, and then transmission module sends these data to embedded system via RF.

Therefore, system development process for monitoring system based on embedded Linux mainly consists of three parts, such as host, embedded system and sensor node.

System development process can be represented as follows:

1) Install OS: Install operating systems for development environment. These are Linux and TinyOS. In Linux, porting of kernel and file system for embedded system is processed.
2) Tool chain: Tool chain as cross compiler tool is used to generate executables for embedded system.
3) Modify Makefile: To transplant monitoring program to set up embedded system, modify some part of Makefile, which are: CC=gcc to CC=arm-linux-gcc, etc.
4) Install monitoring program: Compile monitoring program using a modified Makefile and then install monitoring program which consists of three modules, such as collection, analysis, storage.
5) Install sensor program: Compile sensor program and then install sensor program which consists of sensing and transmission module.
6) Install DBMS: Install embedded DBMS for environmental data management.

It takes a long time to develop monitoring system particularly based on embedded Linux. The proposed system development process promotes the reuse of development process and modules and can reduce development time and errors.

4. Conclusion

Embedded systems are typically designed for a specific application or purpose and come in a variety of shapes and sizes. Also embedded systems are resource constrained and have power limitations. Therefore, embedded systems need slim and real-time operating system. Because of the numerous economic and technical benefits, embedded Linux may be the best choice for a particular embedded system. The development of embedded systems is done by separating the host and target. Application development is performed by the host and application execution takes place on the target. In addition, to collect and analyze in real time data sent from various sensors, a monitoring program is developed through interworking between embedded systems and wireless sensor network. In this paper, we present system development process for monitoring system

based on embedded Linux. Using the proposed system development process promotes the reuse of development process and modules and can reduce development time and errors.

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Authors

ShinHyeong Choi

He received the M.S. and Ph.D. degrees in computer engineering from Kyungnam University, Masan, Korea in 1995 and 2002, respectively. He is currently a professor department of the control and instrumentation engineering at Kangwon National University, Kangwon, Korea, in 2003. His research interests are in embedded system, security and applied ubiquitous sensor network.

Hyoung-Keun Park

He received the M. S. and Ph. D. degrees in electronic engineering from Wonkwang University, Iksan, Korea in 1995 and 2000, respectively. He is currently a professor department of the electronic engineering at Namseoul University, Chungnam, Korea, in 2005. His research interests are in embedded system, applied ubiquitous sensor network.