


# Chapter 8


## A Lightweight Multi-Process Coordination System for Hospital Service Robots With Deadlock Prevention

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### **ABSTRACT**

*This chapter presents a lightweight operating system for coordinating multiple medical care robots in a hospital environment. The system focuses on addressing concurrency and synchronization challenges in multi-process robot coordination.*

DOI: 10.4018/979-8-2600-1101-0.ch008

*A centralized coordinator manages task allocation, resource control, and system monitoring, while robot processes execute tasks independently. An all-or-nothing resource allocation strategy is adopted to prevent deadlock by ensuring that tasks start only when all required resources are available. Inter-process communication is implemented using a lightweight text-based protocol for efficient message exchange. In addition, a heartbeat-based monitoring mechanism is used to detect failures and reclaim resources. Experimental results demonstrate that the system maintains correct synchronization, ensures mutual exclusion, and achieves stable performance under resource contention and partial failure conditions.*

## **1. INTRODUCTION**

### **1.1 Problem Statement and Motivation**

Nowadays, modern hospitals tend more towards utilizing medical care robots to enhance work efficiency. These robots have several clearly defined tasks such as delivery, disinfection, and surgical assistance. A lightweight operating system core is needed to coordinate these robots safely and efficiently.

The core issue is that when multiple robots work concurrently in a shared operating system, concurrency and resource sharing problems will appear naturally at the operating system level. First, when multiple robot process attempts to access the shared task queue simultaneously, there may occur some situations including race condition, task loss, and duplicate task requests. Besides, without constraints, multiple robots may try to enter the same zone, which could lead to resource conflicts, disruption of the normal order of the hospital, and serious safety issues. Moreover, these robots can malfunction or lose connection, which will cause congestion of the task queue without resolving this issue and lead to the entire operating system crashing. Lastly, at the logical level of the operating system, deadlock and multi-process collaboration are also crucial issues to be addressed.

### **1.2 Chapter Objectives**

This chapter is aimed at developing a practical lightweight operating system to coordinate multiple medical care robots with solving the concurrency issues mentioned above. Initially, the function of main process is required to be correctly implemented. The main process will act as the coordinator to start child processes as robot processes to execute tasks and receive resource requests from the child processes. The ResourceManager should be able to properly manage and record zone occupancy and task execution status. In addition, the health monitoring func-

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