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Title:

Development of the Supervisory Agent for Internet-Based Control Systems with Human-in-the-Loop

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1. Introduction

For Internet-based remote control systems, as shown in Fig. 1 (a), certain human operations may violate desired safety requirements and result in catastrophic failure [1]. For such human-in-the-loop systems, this paper proposes a systematic approach to developing supervisory agents which guarantee that remote manual operations meet safety specifications. By applying the mutual exclusion concept [2], the Petri net approach is used to model, design, and verify a supervisory system which prevents human errors. Then, Java technology is adopted to implement the supervisor as an intelligent agent for on-line supervision of the remote control system. To demonstrate the feasibility and practicability of the developed supervisory approach, we apply it to a rapid thermal processor (RTP) controlled over the Internet.

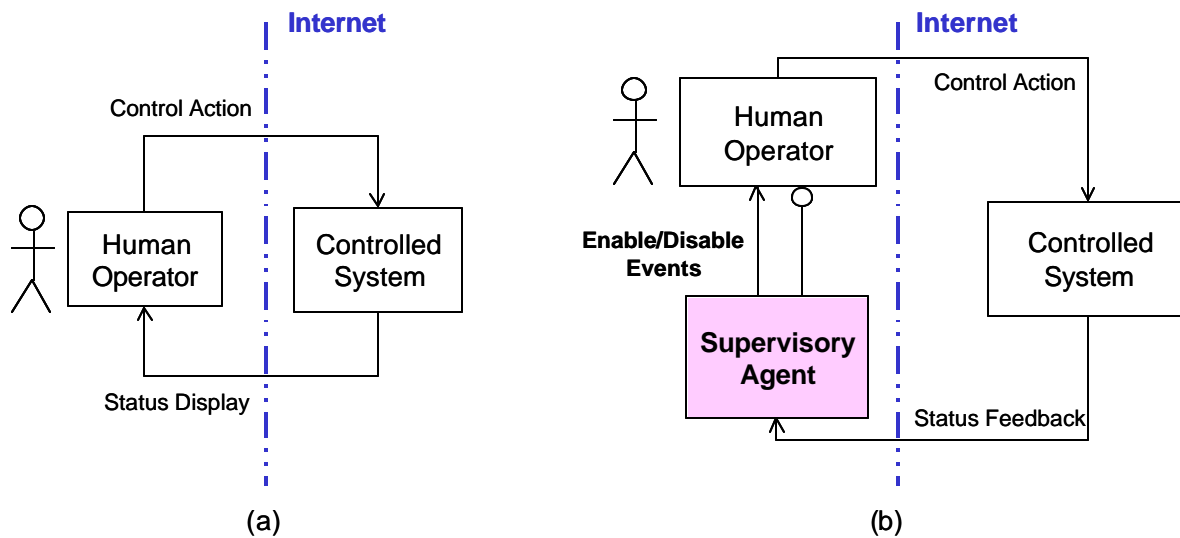


Fig. 1. (a) Typical remote control system with the human in the loop, (b) the proposed remote supervisory control scheme.

2.Method

Fig. 1 (b) shows the proposed supervisory control scheme for a remotely located system with the human in the loop. First, the supervisory agent acquires the system status and makes the decision to enable/disable associated events to meet the required specifications, typically safety requirements. The human operator is then only allowed to perform the enabled events to control the system. The role of a supervisory agent is to interact with the human operator and the controlled system so that the closed human-in-the-loop system meets the required specifications and to guarantee that undesirable executions do not occur. The supervisor design procedure consists of the following steps:

- Step 1)* Construct the Petri-net model of the plant using the task-oriented approach.
- Step 2)* Construct the Petri-net model of the specifications using the mutual exclusion concept.
- Step 3)* Compose the plant and specification models to yield the supervisor model.
- Step 4)* Verify and refine the supervisor model to obtain a live, bounded and reversible model.

3. Case Study

An application of a rapid thermal processor (RTP) controlled over the Internet in semiconductor manufacturing flexible is provided in this study to illustrate the design procedures of the proposed approach.

4.Conclusion

This paper presents a framework for designing and implementing a Petri-net-based supervisor for Internet-based control systems with the human in the loop. The supervisor is systematically designed by applying the mutual exclusion concept and is then implemented using Java technology. According to the feedback status of the remotely located system, the developed supervisor provides allowable commands for human operators while disabling operations which violate safety specifications.

Reference

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