

Supervisory control of MRI scanners



R.J.M. Theunissen, P.A.H. Thijs, R.R.H. Schiffelers,
D.A. van Beek and J.E. Rooda

Eindhoven University of Technology
Department of Mechanical Engineering, Systems Engineering Group
<http://se.wtb.tue.nl>

TU/e

Introduction

In the framework of the Darwin project on evolvability of MRI scanners, supervisory control theory is used to synthesize a supervisor for the patient support system (PSS), see Figure 1.

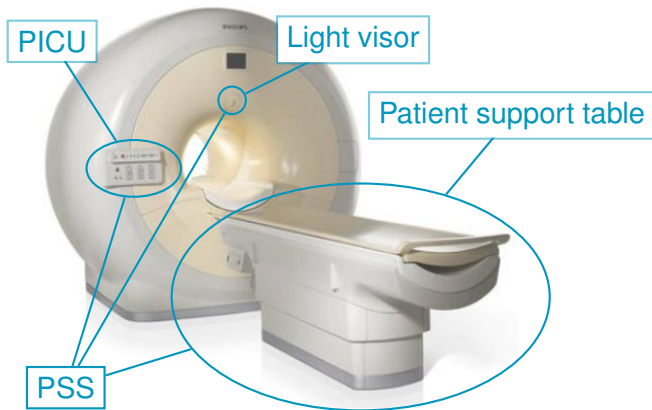


Figure 1: MRI scanner

The PSS is used to position a patient inside a MRI scanner. The system consists of a table and a removable tabletop. It has several sensors and actuators, see Figure 2. The PSS is connected to a user interface for manual control (PICU) and to the main controller of the MRI system for host based control.

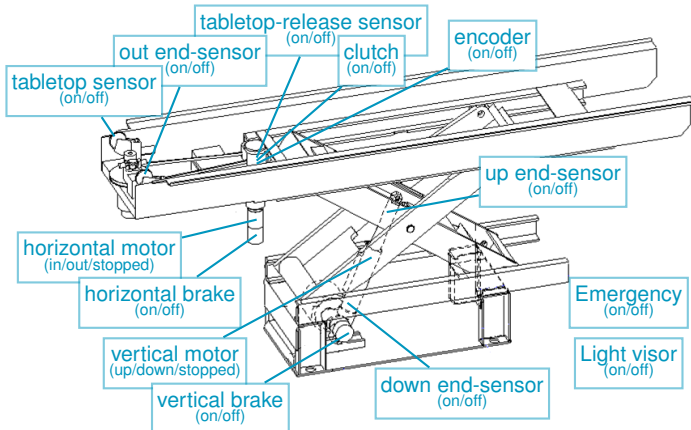


Figure 2: Patient support table

Evolvability

Supervisory control theory helps to improve systems evolvability; after changes in system requirements the following steps are taken:

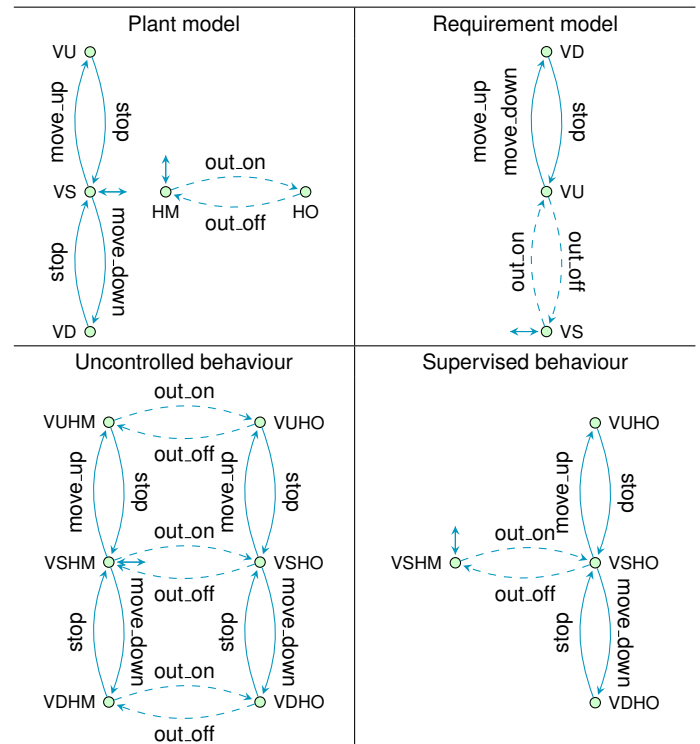
1. Update plant model
2. Update control requirements
3. Regenerate supervisor

To further improve the evolvability of the PSS supervisor, the models are:

- Small
- Loosely coupled

Supervisor specification example

The patient support table may only move vertically if it is horizontally maximally out:



Simulation and real-time control

Monolithic supervisor:

- Light visor and emergency behaviour excluded
- State space: 4.712 states, 33.684 transitions

Modular supervisor:

- Light visor and emergency behaviour included
- 9 components
- State space: 1.420 states, 11.656 transitions (monolithic ca. 1.500.000 states)

Monolithic and modular supervisors have both been tested by means of:

- Simulation with a hybrid χ model of the PSS
- Real-time control on the actual PSS

Results: First time right, no errors.