Temperature regulation

1 Working principle

The system is based on the temperature control system of an oven studied in the thesis of Mr. Gabriel Antonio Perez Castaneda. Some liberty has been taken with regard to the model developed by Mr. Perez Castaneda. The differences will be discussed later on.

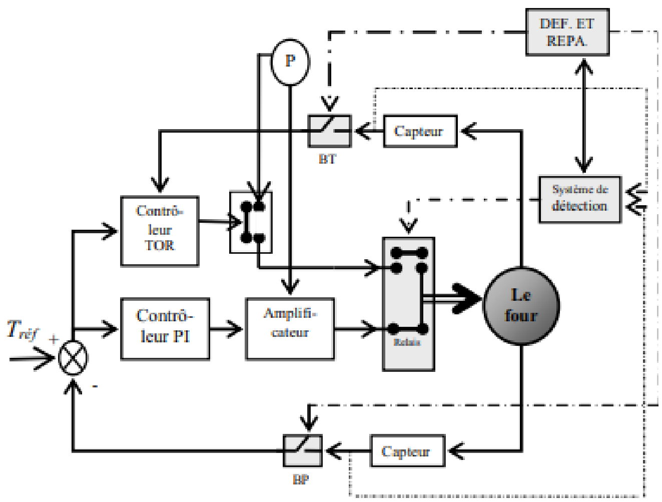

Figure 1: State finite automaton of the furnace (taken from Mr. Perez Castaneda's thesis)

'

The temperature control system has the role of preventing the oven temperature to reach dangerous values. At first the oven temperature is supervised by a PI controller. The temperature control system has to detect whether the oven functioning is defective in the case of a PI controller malfunction. Once a malfunction detected, the system will activate a switch opening the PI loop and closing the TOR one. The oven will be then supervised by the TOR controller until the PI is repaired. However there is still a possibility that the TOR controller meet a malfunction which will cause the oven to operate in open-loop until one of the controllers is repaired.

2 Model

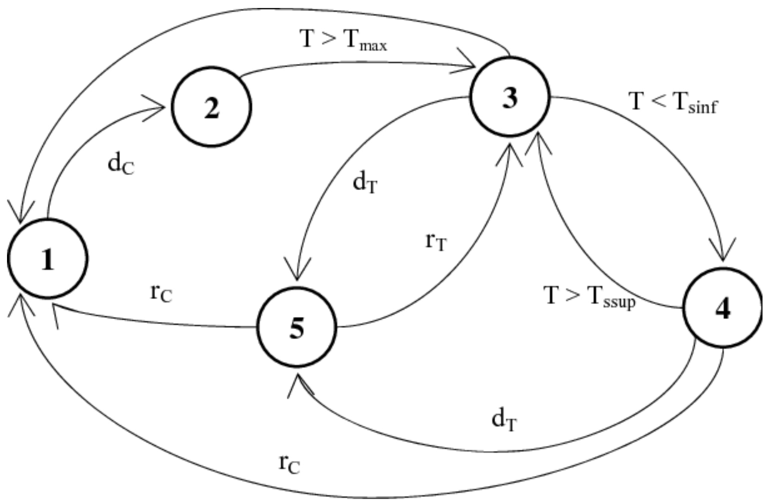

Figure 2: State finite automaton of the furnace (taken from Mr. Perez Castaneda's thesis)

Figure 2 shows the modeling the physical system, the states are defined in the following way:

- **State 1**: Both controllers work and the furnace is linked to the PI controller.
- **State 2**: The PI controller meet a malfunction, the temperature will begin to rise without any control.
- **State 3** and **State 4**: The dysfunction is detected after the temperature exceed a value fixed by the operator. The oven will be linked with the TOR controller. The TOR will impose the temperature to be bounded between two values.
- **State 5**: The TOR controller presents a dysfunction too, the furnace will function without controller.

Each dysfunction can be repaired, the events r_C and r_T represent the reparation while d_C and d_T represent the dysfunctions. In the Sateflow model, d_C and d_T will be modeled as randomized events while the reparation events are modeled by the validation of a timed guard. The assumption here is that the duration during which the dysfunction is detected and repaired is considered constant.

Contrary of the model developed by M. Antonio, the furnace is considered faster, but also presents higher probability of dysfunctions. The reason is because while in the original article, the simulation lasts 250 000 seconds, in our case it will last 1000 second in order to reduce the calculation time. Whichever the state, the evolution of the temperature T is defined by the following equation :

$$K\dot{T} = T + U$$

T being the furnace temperature, U define the final value of T, its value depends on the automaton state. K is a constant. Their values depend on the system state.