

Smart Car Washing System – ESIOT

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Sofia Cipollone
Raffaele Francesco Marrazzo

1. Design and Architecture

Smart Car Washing System is a task-based embedded software that is composed by a cooperative scheduler that manages six tasks, modelled as synchronous finite state machines (*FSM*).

The tasks cooperate with each other via shared variables (referred to from now on as *guards* or *guard variable*), that allow each finite state machine to adjust their current state.

The GuardsManager entity controls the aforementioned variables, providing encapsulation and simplicity.

2. Scheduler

The cooperative scheduler's period is defined by the Greatest Common Divisor (GCD) calculated from all the tasks' periods. This avoids missing relevant events originated from the other tasks.

Every time that the scheduler's period elapses, the scheduler checks for each task's readiness, launching them if said condition is satisfied.

3. Tasks

The tasks' periods have been chosen to avoid missing events, according to the Minimum Event Separation Time (MEST).

The following table contains the tasks with their related periods.

	Period (ms)
Check-in	400
Gate	500
Button	100
Blink led	100 (<i>led L2</i>), 500 (<i>led L2</i>)
Washing	200
Check-out	400

3.1 Check-In

The Check-In task manages the arrival of a car to the washing system by using a passive infrared sensor (PIR) and a sonar.

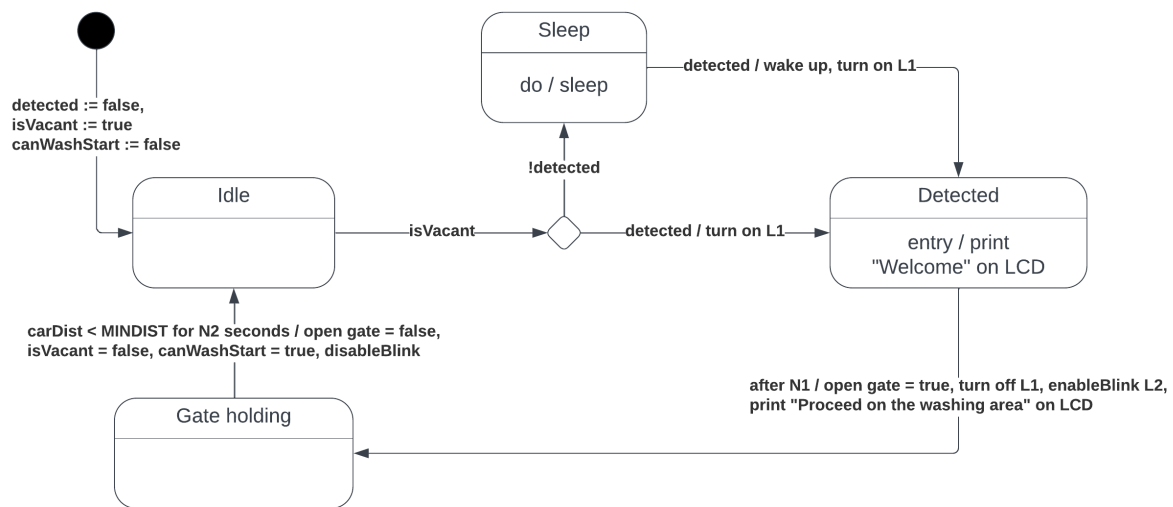
The task starts in an *idle* state: if nothing is detected by the PIR, the FSM goes into a state of *sleep*, otherwise if something is detected by the PIR for more than N1 seconds, the led L1 is turned on and a welcome message is printed on the LCD screen.

The gate, modelled with a servo motor, is then opened to let the car through and is subsequently closed after the sonar perceives the presence of the car for more than N2 seconds. During this state (*detected*) L1 is turned off and L2 starts blinking as well.

After the gate is closed, L2 stops blinking, the task goes back into the *idle* state and the system is ready to start the washing process.

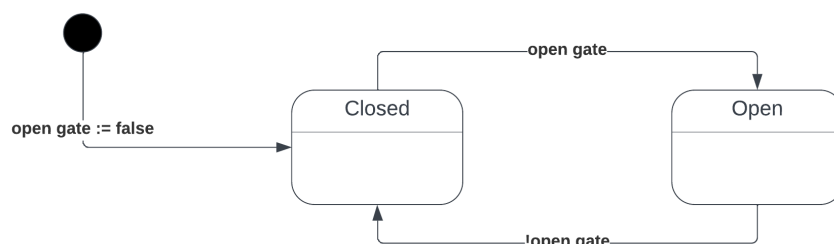
The guard variables in this FSM, *isVacant* and *canWashStart*, are respectively used to synchronise between the check-out task and the washing task.

The `isVacant` guard is used to check if the washing area is occupied by a car and `canWashStart` is used by the washing task to check if the washing process can start.



3.2 Gate

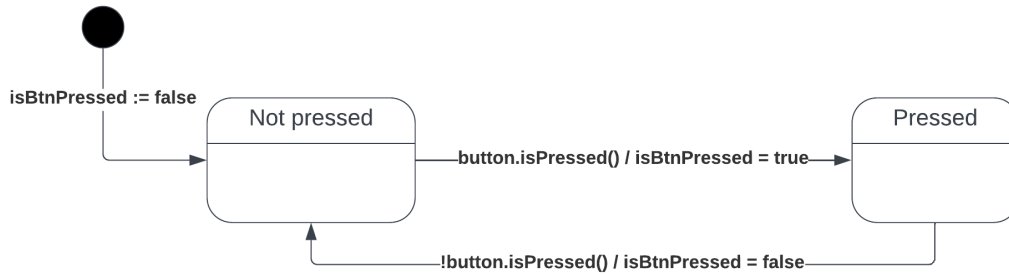
The gate task manages the opening and the closing of the gate. When the gate is closed and another task sets the *open gate* variable to `true`, the gate is opened. On the other hand, if the gate is open, and a task sets the before-mentioned variable to `false`, the gate is closed.



3.3 Button

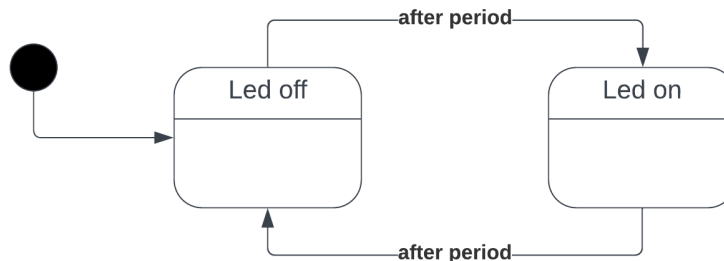
The button task manages the pressing of the button. When the machine is in the state *Not pressed*, if the button is pressed, the machine goes in the *pressed* state.

Otherwise, if the machine is in the *Pressed* state, when the button is no more pressed, the machine switches in the *Not pressed* state.



3.4 Blink led

This task manages the blinking of a led. When the task is started, the LED is off. After *period* seconds, the LED is switched on, and after *period* seconds, the LED is switched off, and so on.



3.5 Washing

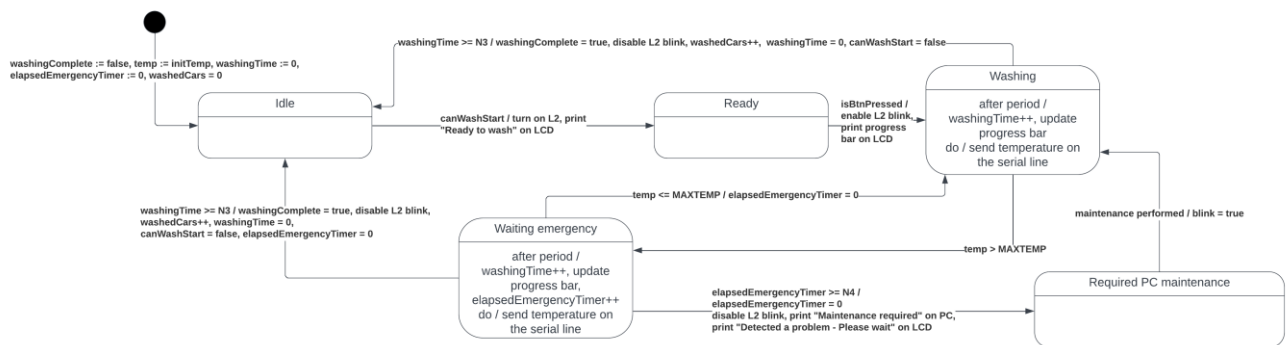
The *Washing* state manages the washing phase. At the beginning, the machine is in the *Idle* state.

When the Check-in task is terminated, the variable *canWashStart* is set to true, and so the machine goes into the *Ready* state. In this state, the machine waits for the user to press the button to start the washing phase.

During the washing, a progress bar is shown on the user monitor, and the temperature of the system is sampled to avoid overheating.

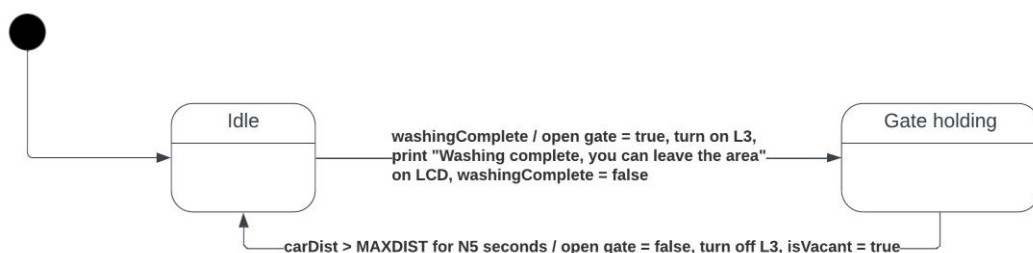
If the temperature is greater than MAXTEMP, the machine goes in the *Waiting Emergency* state. In this state, the washing process continues but, if the temperature is greater than

MAXTEMP for more than N4 seconds, the FSM goes in the *Required PC Maintenance* state. In this state, the user must wait for the maintainer to solve the issue. When the problem is solved, the system continues to wash the car, by returning in the *washing* state. If the FSM is in the state *Waiting emergency* and the temperature becomes less than MAXTEMP, the machine goes back in the *Washing* state. When the washing process is finished, the FSM goes back to the *Idle* state. The washingComplete guard signals the check-out task that the washing process has ended.



3.6 Check-Out

The *Check-Out* task starts in the *Idle* state. When the washing phase is terminated, the gate is opened and, when the sonar measures a distance greater than MAXDIST for N5 seconds, the gate is closed, and the FSM goes back in the *Idle* state.



4. Circuit Design

