RTOS PROJECT DOCUMENTATION

2024

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2024

Free-RTOS Final Project

Seat Heater Control System

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1- Tasks of the Project:

1- prvSetupHardware :

This task involves initializing all hardware components required for the project, including UART0, GPTM, GPIO, and the sensors for both the driver's seat and passenger's seat.

Periodicity: this task Aperiodic, this task called one in the project before all tasks.

2- vPeriodic_driver_TeampRead:

This task involves continuous monitoring of the driver seat sensor to detect its readings.

Periodicity: 500 ms

3- vPeriodic_passnegerSensor_TeampRead:

This task involves continuous monitoring of the passenger seat sensor to detect its readings.

Periodicity: 500 ms

4- vDriver_Seat_Button:

This task continuously monitors the status of the driver's heater button. If any change in the button state is detected, it takes appropriate action based on the heater status, which can be Off, low speed, medium speed, or high speed.

Periodicity: 250 ms

5- vPassenger_Seat_Button:

This task continuously monitors the status of the passenger's heater button. If any change in the button state is detected, it takes appropriate action based on the heater status, which can be Off, low speed, medium speed, or high speed.

Periodicity: 250 ms

6- vSteering_Button:

This task continuously monitors the status of the driver's heater button from the steering, if any change in the button state is detected, it takes appropriate action based on the heater status, which can be Off, low speed, medium speed, or high speed.

Periodicity: 250 ms

7- vDriverSeat_Temperature:

This task involves monitoring the value read from the driver's heater sensor and controlling the heater status based on the temperature reading, before taking any action, the task checks for any errors in the sensor reading, such as out-of-range values.

Periodicity: 500 ms

8- vPassengerSeat_Temperature:

This task involves monitoring the value read from the passenger's heater sensor and controlling the heater status based on the temperature reading, before taking any action, the task checks for any errors in the sensor reading, such as out-of-range values.

Periodicity: 500 ms

9- vDriverSensor_displayData:

This task involves displaying all relevant data about the driver's seat, including the temperature level, heating level, and heater status.

Periodicity: 1 s

10- vPassengerSensor_displayData:

This task involves displaying all relevant data about the driver's seat, including the temperature level, heating level, and heater status.

Periodicity: 1 s

11- vSeat_sensorEfficiency:

This task involves checking the efficiency of the sensors and providing the driver with alerts if any errors occur.

Periodicity: this task Aperiodic, it resumed from suspend state if any error happen in any sensor.

12- vRunTimeMeasurementsTask:

This task involves displaying all relevant data about the system, including the CPU load, time consumed by all tasks, and the execution time of each individual task

Periodicity: 1 s

2- Key Utilized Features from Free-RTOS:

1- MUTEX:

Utilizing a mutex with the handler named xUART0_Available, this mutex ensures the safety of a shared resource (UART) by preventing conflicts between data access, the task that requires this resource is:

a- vDriverSensor_displayData
b- vPassengerSensor_displayData
c- vSeat_sensorEfficiency
d- vRunTimeMeasurementsTask

2- Event Group:

the event group is used to indicate errors related to seat sensors.

Two tasks are responsible for setting the event bits:

vDriverSeat_Temperature: Sets a specific bit when an error occurs in the driver's seat sensor.

vPassengerSeat_Temperature: Sets a specific bit when an error occurs in the passenger's seat sensor.

The task named vSeat_sensorEfficiency monitors the event bits set by the two tasks mentioned above.

For each bit, it checks whether the error condition has occurred, if an error bit is set, the task takes specific actions (as defined in the source code).

3- Queue:

Used 4 queues in this project (as defined in the source code) :

a- Queue with handler called xDriver_Sensor_Reads_Queue this queue used for storing the current and previous reading of the driver seat sensor by using Free-RTOS API called xQueueSend.

b- Queue with handler called xPassneger_Sensor_Reads_Queue this queue used for storing the current and previous reading of the passenger seat sensor by using Free-RTOS API called xQueueSend.

c- Task vPassengerSeat_Temperature: Utilizing a queue with the handler named xError_passengerSensor_Reads_Queue, this queue is designed to store sensor reading errors, when the number of errors reaches the queue's predefined limit, the task responsible for efficiency monitoring (vSeat_sensorEfficiency) will resume, the efficiency task then takes action to suspend the task responsible for controlling the sensor's temperature.

d- Task vDriverSeat_Temperature: Utilizing a queue with the handler named xError_driverSensor_Reads_Queue, this queue is designed to store sensor reading errors, when the number of errors reaches the queue's predefined limit, the task responsible for efficiency monitoring (vSeat_sensorEfficiency)

will resume, the efficiency task then takes action to suspend the task responsible for controlling the sensor's temperature.

3- Simso Simulation:

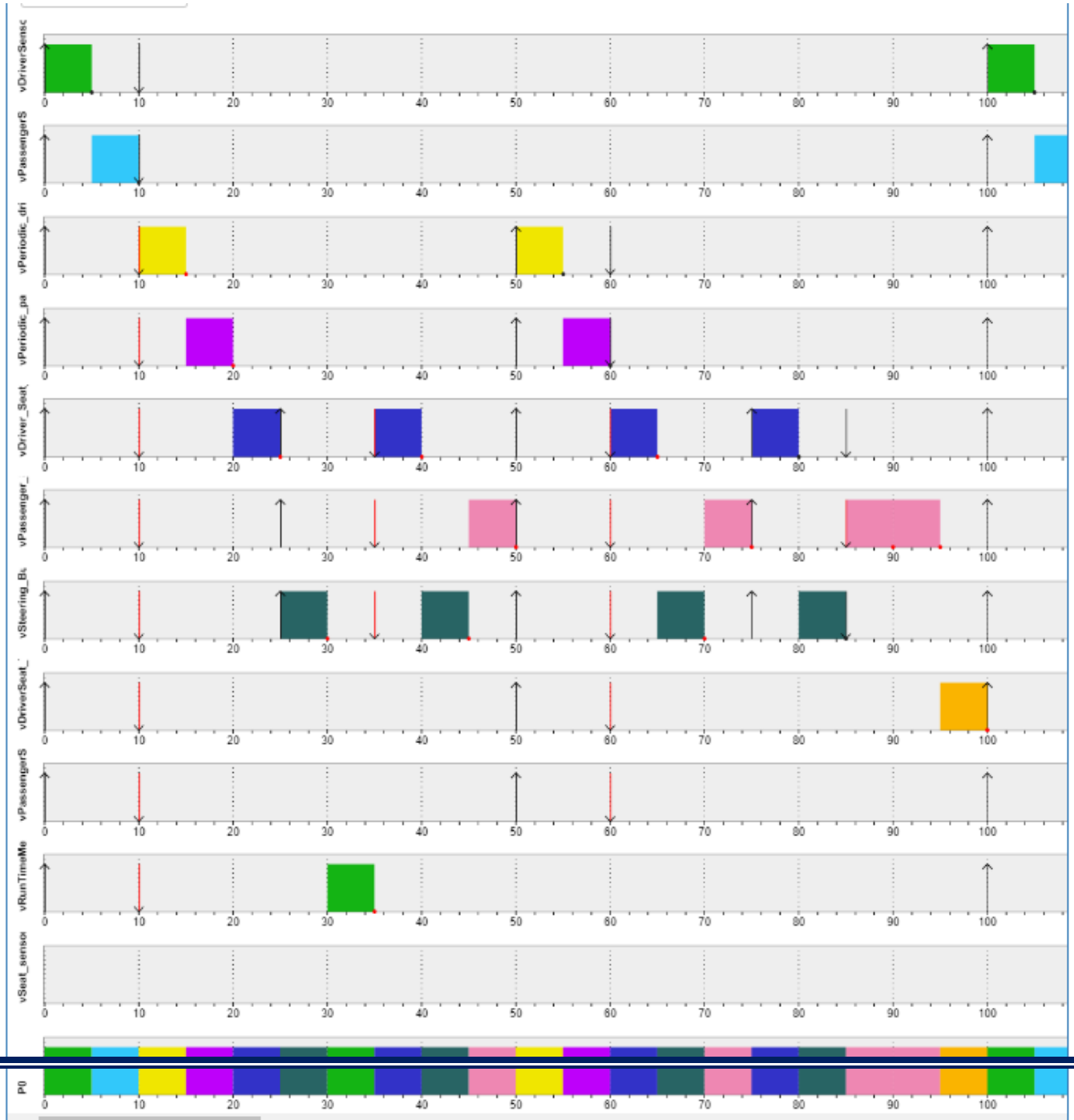
Note: In simso the all tasks periodicity were divided by 10 (normalized), to be able to monitor the simulation.

General | Scheduler | Processors | Tasks

Duration (cycles)	200000000
Duration (ms)	200
Cycles / ms	1000000
Execution Time Model	WCET

General | Scheduler | Processors | Tasks

id	Name	Task type	Abort on miss	Act. Date (ms)	Period (ms)	List of Act. dates (ms)	Deadline (ms)	WCET (ms)	Followed by	Pirority
1	vDriverSensor_displayData	Periodic	No	0.0	100.0	-	10.0	5.0		5
2	vPassengerSensor_displayData	Periodic	No	0.0	100.0	-	10.0	5.0		5
3	vPeriodic_driver_TeampRead	Periodic	No	0.0	50.0	-	10.0	5.0		3
4	vPeriodic_passnegerSensor_TeampRead	Periodic	No	0.0	50.0	-	10.0	5.0		3
5	vDriver_Seat_Button	Periodic	No	0.0	25.0	-	10.0	5.0		3
6	vPassenger_Seat_Button	Periodic	No	0.0	25.0	-	10.0	5.0		2
7	vSteering_Button	Periodic	No	0.0	25.0	-	10.0	5.0		3
8	vDriverSeat_Temperature	Periodic	No	0.0	50.0	-	10.0	5.0		1
9	vPassengerSeat_Temperature	Periodic	No	0.0	50.0	-	10.0	5.0		1
11	vRunTimeMeasurementsTask	Periodic	No	0.0	100.0	-	10.0	5.0		3
10	vSeat_sensorEfficiency	APeriodic	No	-	-	-	10.0	5.0		3


vDriverSens
vPassengerS
vPeriodic_dri
vPeriodic_pa
vDriver_Seat_
vPassenger_
vSteering_Bu
vDriverSeat_
vPassengerS
vRunTimeMe
vSeat_sensor
P0
0
10
20
30
40
50
60
70
80
90
100