Hybrid Modeling of a Vehicle Surveillance System with Real-Time Data Processing

A Case Study on Pre-Crash Detection *

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In this abstract we report on an industrial case study carried out in the context of the EU-funded multinational project AMETIST. The case study has been provided by Robert Bosch GmbH [4], and is concerned with the analysis of car's periphery supervision system based on short-range radar sensors placed around a car.

The radar sensors can operate in two modes [5]. In one mode a sensor scans an angular area in front of it and provides a list of distances to the objects it has witnessed. In the other mode the sensor waits for a certain barrier to be crossed by an object and then immediately reports this fact.

The information from the sensors is received by a processing unit located inside the car. This unit performs computation and coordination tasks which run on the OSEK [2] operating system. The processing unit assesses correctness and reliability of the data provided by the sensors and combines their individual views on each object (triangulation) into a list of two-dimensional object. Depending on the position of objects calculated, the processing unit may switch the sensors' mode of operation.

The information about the car's periphery is transmitted to actuators in the cockpit, such as a belt-tensioning device, an air-bag controller, etc. These devices can take appropriate action prior to collision, such as tensioning a belt in advance. Providing the information too late will render some of the devices useless, and, on the other hand, providing inaccurate information to them may lead to false alarms or other malfunctioning of the system.

The goals of the project are:

- to analyze the problem domain,
- to capture the user and system requirements,
- to come up with a design of the processing unit tasks,
- to perform the validation and verification of the system using techniques of logical and timing analysis.

As a result of the domain analysis we already determined the physical characteristics of the cars, and possible sensor locations. We have also analyzed the extreme values of the relative speed of approaching objects and their relative (de-)acceleration, and gathered the classes of possible obstacle approach trajectories. When capturing the requirements we take into account the sensors characteristics, the computation and communication delays of the processing unit, and the timing and dependability requirements of the information consumers.

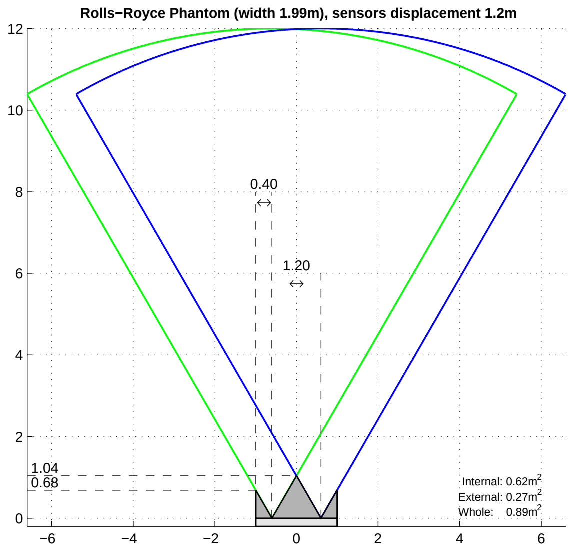

Figure 1: Sensors visibility areas.

We use MatLab to visualize the sensors visibility areas and the possible trajectories (cf. Figure 1). Based on the requirements we modeled the behavior of the system and its environments in UPPAAL [3] and MODEST [1]. We are currently working on model checking logical properties and timing analysis of the models.

References

[1] MODEST. http://fmt.cs.utwente.nl/HaaST/modest.html.

[2] OSEK/VDX real-time operating system. http://www.osek-vdx.org.

[3] UPPAAL. http://www.uppaal.com/.

[4] Stefan Kowalewski and M. Rittel. Real-time service allocation for car periphery supervision. Deliverable No. 3.1.3 for IST Project AMETIST, September 2002.

[5] Rainer Moritz. Pre-crash sensing - functional evolution based on short range radar sensor platform. In *SAE Conference*, number 00IBECD-11, Detroit, USA, 2000.

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