Table of Contents

C.1 Introduction

We envision a next generation driver information system, ReVision, that will utilize state-of-the-art technology to deliver critical information to race-car drivers in real-time during training and race activities. ReVision has the ability to be quickly adapted to new instrumentation and other vehicles, changing needs, requirements, and technology.

In this document we will present the stakeholders and their high-level goals for this system and how this system should realize that vision.

C.1.1 Definitions and abbreviations

See project dictionary.

C.2 Background

To understand all the concepts discussed in this document and other design documents it is necessary to have some knowledge about the domain of automotive vehicles and automotive electronics. This section contains a quick introduction to these areas.

C.2.1 Automobile electronics

Todays automobiles are complex machines when compared to 50 years ago when they had an engine, transmission, a fuel system and a cooling system, some brakes and a clutch. Modern cars are often equipped with systems for emissions control, adaptive suspension, ABS, traction control, airbags, and intelligent gearboxes.

Both racing and personal vehicles are fitted with complex mechanical and electrical systems being controlled mostly by small embedded computers. For these systems to be able to know what they are doing they need input data about the state of the surrounding and controlled systems. This data is gathered by means of sensors registering real-world factors like position, temperature, pressure, and flow.

These systems consists of many components located at various places within the car. Sensors that detect collisions and wheel speed are examples of sensors often fitted very far away from their control units. Some sensors are often much closer, but it is still difficult to contain a system to a small area of a vehicle.

Wires are basically antennas and are susceptible to catching induced currents from magnetic fields, and also emits their own magnetic fields when current is applied. Petrol engines use high-voltage components that may create a lot of noise if not shielded properly. This often results in noisy electrical environments, something even modern cars struggle with. Automobile electronics have to be designed to tolerate very high transient voltages.

C.2.2 Sensors and control networks

Traditionally sensors used to be directly wired to the control unit, but as system complexity and the number of sensors grew this became increasingly difficult to handle. The solution was to utilize digital communication buses which allowed components to talk with each other and reduced the amounts of wires considerably. The most significant bus-standard is the Controller Area Network bus (“CAN-bus”) that was developed specifically to be used for automotive purposes and is very error-resilient [**?**].

In a CAN system connected nodes communicate by sending messages (’frames’). Frames have an id which is also the priority of the message (lower number = higher priority), if two nodes attempt to send at the same time the frame with the highest priority will be transported over the bus, the losing node will retry when the bus is clear. [**?**]

Most sensors are in their very nature analog and thus requires their output values to be represented digitally. Although some modern sensors come with digital outputs, most sensors requires peripheral components that adapt an output voltage to a level suitable for digitalizing before an analog-to-digital converter reads the voltage and can communicate it to other digital components, most commonly a micro controller unit (MCU). The MCU would then take the value from the sensor, wrap it in a CAN-frame and transmit it on the CAN-bus, either at its own accord or when requested from another node. [**?**, loc. 5020-5203, 5732-7565][**?**]

C.3 Positioning

C.3.1 Business Opportunity

Existing driver information systems (DIS) are usually implemented as dashboards that requires the driver to look down. Even in motorsport this still rings true today. Racing is an activity with a high pace and there is little time to look at instruments and dials. Traditionally these systems are therefore simple in nature, and tailor-built for the car they are mounted in. They indicate activity by using lamps or big numerical displays or gauges. These design are static and requires the driver to remove focus from the road. Using state-of-the-art technology gives the possibility to create a flexible solution which resides in the drivers field-of-view, a so-called Heads-up Display (HUD), that overcomes the challenges plaguing traditional solutions.

C.3.2 Problem Statement

Traditional dashboard solutions are static and inflexible. In compact one-seat race cars they take up significant amounts of space that could be repurposed, or removed to lower weight. Moving one system from one car to another is not even part of the design considerations. Traditional systems are designed with that car in mind. During competition driving these systems are almost never used; the driver isn't able to perceive much information during racing, and there is no way to give or visualize complex information [**?**, Appendix A] . They don't accommodate the varying needs of various user groups. A car that is being used in a training context could benefit from different configurations than one being used in a competition (race) context.

C.3.3 Product Position Statement

ReVision is a computerized information system that is easy to adapt to different demands and requirements, portable and flexible. It can be tailored to the varying needs of different target groups, from novice amateur racers to professionals trying to get the most out of the car during a serious competition.

C.3.4 Alternatives and Competition

Today there exists very few solutions like this on the open market [**?**], although the time seems to be ripe; 2013 has seen a flood of prototypes [**?**, **?**, **?**, **?**]. They are, however, all going after the consumer market, and most are targeted towards motorcyclists. With ReVision we are aiming to cater for professional and amateur racers.

C.4 Stakeholder Descriptions

ReVision is being developed in co-operation with Revolve NTNU [?], and the specifications and requirements for the system are partially given by the frames set by the Formula Student (FS) competition-rules [?, ?, ?]. The competition rules dictate that there exists a business plan for the developed car, targeting the car towards 'the nonprofessional weekend autocross racer' [?].

Considering a working business model would allow the product to be sold to consumers or enterprises that provides racing experiences to consumers these should also be considered as stakeholders. This should result in more realistic requirements.

C.4.1 Stakeholder (Non-User) Summary

Two obvious stakeholders are Revolve NTNU and the judges in the FS competitions. Also any enterprise owning vehicles with such systems are non-user stakeholders. Common for all of these stakeholders is that the attractiveness of the system is important. For Revolve NTNU the system could help attain higher scores in the competition, both in the static and dynamic events [?]. For the judges, who in the competitions pretend to be investors, the system's ability to differentiate itself from the competition in a positive way is important, but also the possibility that such a system could attract customers is something that should result in a higher score.

Another stakeholder are enterprises purchasing the system for integration into existing vehicles, or purchasing vehicles with the system integrated. In this case the ability to differentiate itself from other providers of similar services is important, so is the ability to customize the product and experience to suit customer needs and demand.

C.4.2 User Summary

The users of the system consists of two primary groups; professionals and non-professionals. Common for both of them is that they will use to system for training purposes. Professionals will also utilize the system in race contexts, and the non-professionals might do so.

C.4.3 Key High-Level Goals and Problems of the Stakeholders

High-Level Goal	Priority	Problems and Concerns	Current Solutions
Real-time processing and visualization of acquired data	High	More time needed for processing as amount of data grows. More time needed for processing as graphical transformations.	Existing systems avoids these problems by being simple and handle less complex information.
Flexible architecture allowing portability and adaptability	High	Too tailored architecture to one design will make it difficult to reuse the system, or create a new implementation for another design. Lack of configuration flexibility will increase testing time and leave little room for further innovation.	Existing systems do not address these issues.
Ability to accumulate data and/or display certain data at triggered points, and the ability to define these triggers.	Medium	Certain events, timed occurrences can trigger the need to show data (lap time for instance). Giving more information can be disturbing to the driver under certain circumstances.	Existing systems output information when it is received/registered and therefore do not address this issue.
Robust and reliable data processing	High	Data loss or corruption can mislead or distract driver if not handled correctly. Wireless communication increases chances of data loss and failures.	Existing systems doesn't indicate anything when no information is received. Robustness is given through wired connections.

General support for networking standards	Low	Hard-coded support for networking makes it difficult to move the system over to a design utilizing another network standard	Existing systems are usually hard-coded to the network used in the design.

C.4.4 User-Level Goals

The users need a system to fullfill these goals:

- Developer: Configure message formats, Configure sensors, Configure display, Upload configuration
- System implementer: Configure message formats, Configure sensors, Configure display, Upload configuration
- System owner: Configure sensors, Configure display, Upload configuration, Display real-time information, Receive and display messages
- Revolve NTNU: Configure message formats, Configure sensors, Configure display, Upload configuration, Display real-time information, Receive and display messages
- Driver: Configure display, Upload configuration, Display real-time information, Receive and display messages

C.4.5 User Environment

The user environment is in the driver seat of a race car. For Revolve NTNU this is an one-seater open formula student class race car, but theoretically it could be any kind of vehicle construction. The system is designed to be mounted or worn on the inside of the helmet, with minimal or no interaction from the driver during use/race conditions. Interaction with the system is mainly done from a secondary control system.

C.5 Product overview

C.5.1 Product Perspective

Placeholder text. Also, insert system context diagram.

C.5.2 Summary of Benefits

Supporting Feature	Stakeholder Benefit
Functionally, the system will provide all the common functionality of a traditional dashboard, including speedometer and warning indicators.	Increased availability of information for the driver.
Support for receiving messages over wireless link.	Allows for giving messages without using radio-communication.
Real-time processing and evaluation of sensor data.	Ensures that system has comparable response times of traditional static systems
Support for event-driven display of information.	Less intrusive interface that results in fewer distractions.
Configurable message formats, sensor setups, and display configurations.	Gives a very flexible system that is portable and allows for reuse of high-level components.
Externally configurable with support for upload of stored configurations and ability to create configurations while not connected	Gives a flexible way of configuring without requiring access to the vehicle for long periods.
Support for aggregation of data from sensors and triggered display	Allows for showing information when it is relevant, creating less noise at other times.

C.5.3 Assumptions and Dependencies

The realization of the system depends on the availability of a heads-up display of some sort. Without this component the system can not be realized. For purchasing components there is a dependency on funds, which hopefully will stem from sponsors co-operating with Revolve NTNU.

C.5.4 Cost and Pricing

The prices of solutions for realizing a functional system ranges from USD 200 and up to USD 5,000 for the most costly solutions.

C.6 Summary of System Features

The system under discussion is an advanced Heads-Up Display replacing a traditional dashboard-type instrumentation with a wide feature set:

- Aggregation of data and event-driven display updates.
- Real-time processing and display of data.
- Wireless reception of messages with duplex communication.
- Flexible configuration possibilities.
- Remote configuration capability.
- Stored configurations.
- Portable architecture.
- High-level support of various network standards.

References