Universität Bremen

Proposal for a Master thesis:

Development and implementation of communication architecture enabling road train

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28.01.2012

1 Introduction

The technology of cars grows yearly thus pushing the auto-mobile industry most of the time to innovate. To that effect the "*Deutsche Forschungszentrum für Künstliche Intelligenz*"(DFKI) in Bremen is having a project called EO smart connecting car since approximately two years ago. The project is about an intelligent electric car that aims to be autonomous in future. This means it will operate without human intervention. The car is very flexible and can adapt its form according to the traffic conditions on the street or highway.

The car is able to individually move all its wheels. Equipped with hub motor, the wheels move up till 90 degrees allowing the car to drive in various directions (i.e., driving and turning, driving diagonally, turning on the spot, folding and going 90 degrees sideways, driving with attached modules, driving in road trains). Its capacities of reducing its length and increasing its height enable it to park, fit and drive in very small environments.

The EO car has the ability to dock or to be docked by others cars. Together they build a road train. The first car on the road train is the master and the other attached cars are slaves. The master has the control over the road train. He gives the permission to dock on the road train. He communicates with slave during the journey about changes in road train. The drivers in slave cars reacts only when they receive authorisation from master. Docking in road train reduces the traffic on the way and slaves with low batteries have the opportunity to charge their batteries [1]. Energy is in road train efficiently used. Some of the reasons are that slaves drive in the master's slipstream and don't need use all their functionality (i.e. driving light).

2 Motivation

As the EO car will be independent from human in future, the communication technology would be an indispensable factor for connecting an EO car to different EO cars going to the same direction. For security reasons, the docking manoeuvre must be automatic. The connection may take place at a fixed point or on the street during the driving. This connection on road train is electro-mechanic and placed at the rear and the front of the car. It is through this connection, that they would continue communicating. Various situations can happen on the street in road train. Some of the cars are disconnecting from a road train and/or reconnecting to another road train. Others may want to charge their batteries. To achieve these goals, it is important to take note of all the details of likely situations. None of the cars can connect anyhow onto a road train or disconnect from it at any time. In case they connect to it, they still have to keep communicating. The information flow has to be controlled and organized to avoid collisions or missing informations, that can be very important for the road train.

Auto-mobile communication has become very important this last decades. Cars have to be equipped on the street by radios in order to receive information about the weather, traffic conditions such as jams, sudden incidents like accidents, bush fires etc. Communication implies also the use of a navigation system to describe the road from one point to another. It is also called "*car to infrastructure*" communication. An example of this, was a project working on establishing communication among cars to avoid collision on the street [2]. Another group of cars communication is the "*car to car*" communication, Enabling car to exchanges informations. The project SARTRE based on this previous communication, was about trucks platooning without mechanical connection, to share their velocity to other following trucks or passengers cars [3]. In order to make road train possible, it is important to mention the CoHoN's project by DFKI, which specifies the communication's structure within a robot and between robots [4]. Comparing with the EO car, it will be possible to communicate wireless on the street, and in road train by using the wire connection for informations exchanges. These informations can be velocity, steering angles, tasks, cars positions and identifications. Developing the architecture of the communication between EO cars in road train underlies the motivation

of this work.

3 Goals

The goal of the work is the development and implementation of a communication architecture enabling road trains. On the street there are many scenarios that can take place. Describing the scenarios will be done to present the information flow between various EO cars. Before the physical connection, the EO cars will be communicating via wireless. What types of wireless connection are they going to use? How will they recognize the presence of other EO cars from afar? After connecting, they will continue exchanging through the wire. How is it going to be realized? The EO cars may be moving with high velocity on highway. The sent and received data have to reach the goals. Which measure can be taken to avoid missing these data? The switching between wireless and wire is to be taken into consideration. The car uses electrical energy and for this reason energy consumptions of the communication will be a point not to be neglected. What about the security of the communication? The communication has to be fast, safe and secure. The different part on which this work will focus are listed bellow:

1. **Requirement specification**
   This part will present and define the problems about the communication between EO cars. The different scenarios about the communication on street will be brought out. In another words, how does the communication before the road train and in Road train look like? Some literature research will be developed for acquiring arguments for solutions. Then the list of different requirements will be done. Criteria will be set up to evaluate successful communications.

2. **Presentation and comparison from network communication**
   Here the different characteristics about wire and wireless technology will be explained. The existing topologies that can be used will also be presented. Comparison will be done to clarify the differences.

3. **Solutions conception**
   Depending on previously defined EO communication needs, the chosen wire and wireless connection will be intensively reviewed. Handling the switching between wireless and wire connection will be focused in this part. The available EO cars or road train are supposed to be recognize by others EO cars on the street. This problem will be solve here. Wire communication on road train will also be described. EO cars are not yet on stage of being tested, simulating some of the described scenarios using the chosen developed communication will be very helpful.

4. **Test and evaluation of the applied solution**
   This part concentrates on testing the developed simulations. The results are going to be taken of and evaluation will be done.

The picture below shows an example of a EO car trying to connect to a road train.

Figure 1: Road train

4 Plan

The following plan shows in months, how the described goals will be developed.

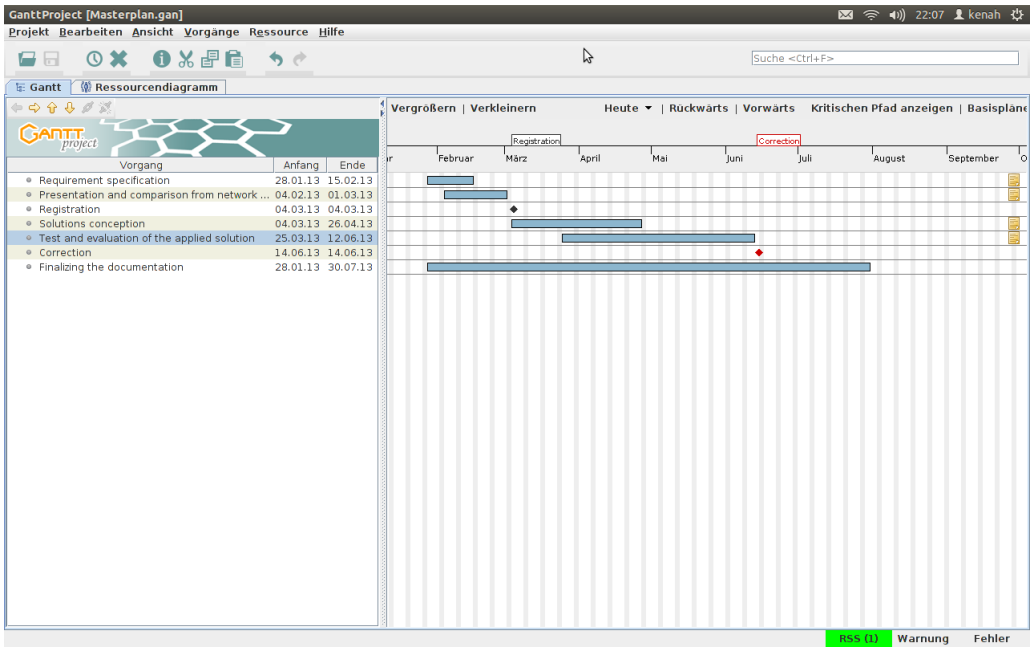

Figure 2: Master plan

References

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