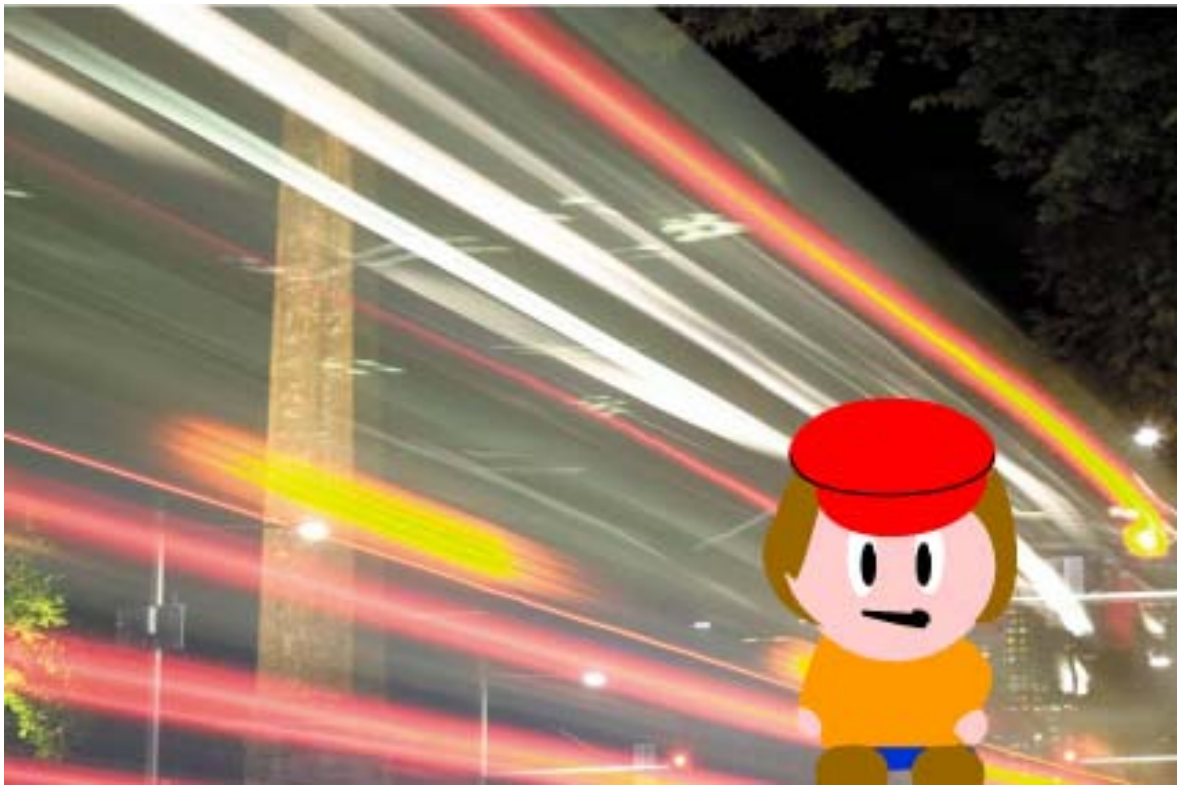
Sentient Guardian Angel

Contribution to Sentient Future Competition – Vision 2015



Authors:

Marcus Christ, Gerald Eichler, Klaus Miethe, Stefanie Richter, Jens Schmidt, Jens Wukasch

Private federation of people interested in research and development of new ideas.

Contact Person:	Stefanie Richter
Address:	Dieburger Str. 32, 64287 Darmstadt, Germany
E-Mail:	mail@stefanie-richter-online.de
Phone:	+49 177 6947732

Darmstadt, November 30, 2005

1 Sentient Guardian Angel

1.1 Motivation

This proposal emphasizes the use of wireless sensor networks to omit dangerous traffic situations for elderly pedestrians, children as well as for disabled persons and pets. Communication between the networks of the participants is used to detect the threat at an early stage giving adequate warnings, alerts recommendations and instructions to all participants involved.

1.2 State of the Art

The statistics for traffic accidents show increasing rates for accidents with children or seniors involved [1]. Noise reduction of motorized vehicles is estimated to contribute to this tendency as well as increasing mobility as well as people getting generally older.

Despite the fact of an increasing number of sensors, making life for drivers and passengers of cars easier and safer there are no systems assisting pedestrians or cyclists. Examples for driver assistance systems are e.g. Daimler Chrysler's Distronic, a radar based distance control [2] and Daimler Chrysler´s Dedicated Short Range Communication (DSRC) system under development [3].

Clothes attached with different kinds of sensors and actors (I-wear [4]) can be used as appropriate equipment for pedestrians and cyclist to enable "Sentient Guardian Angel" functions.

1.3 Vision

The sensor system is supposed to prevent dangerous traffic situations in everyday life. Imagine a handicapped person intending to cross a street. The pedestrian's perception and attention is limited.

The following pictures illustrate such a situation as well as the point of view of the pedestrian and the vehicles driver.

A handicapped pedestrian (e.g. deafness) intents to cross the street. As a car is approaching he does not recognize the vehicle because of his handicap.

However, the Sentient Guardian Angel builds an ad-hoc network exchanging information. The system evaluates the information and recognizes the approaching car.

The driver of the car might not realize the pedestrian as well, e.g. due to bad weather conditions. The Sentient Guardian Angel recognizes the pedestrian and sends warnings to the driver. This enables the driver to react on the “abruptly” emerging person.

The system guards in several cases:

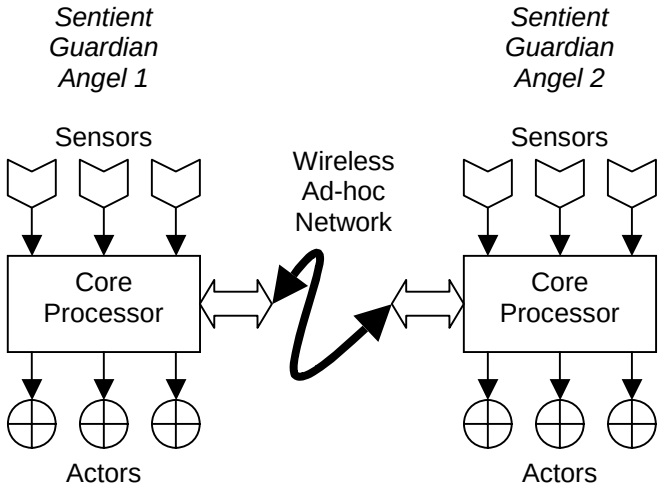
- The pedestrian is warned by the system, e.g.,
  - Causing vibration on the concerned side of the persons body
  - Causing noise or other warnings
- The pedestrian draws attention due to actors
  - The person is illuminated or the clothes are separating coloured light
- The vehicle driver is warned by the system.
  - A sign flashes next to the car’s dashboard
  - Causing noise or other warnings
- The vehicle warns the pedestrian
  - The headlights of the car flash up
  - The car alerts a horn

1.4 Technical Architecture

The basic equipment of the Sentient Guardian Angel is a system consisting of the following components:

- Sensors (to detect and quantify environmental factors)
- Actors (to indicate dangerous situations and give appropriate advice)

- Wireless communication components (to build ad-hoc networks between involved parties)
- Core processor (to control components and predict critical situations)



Such a system will be designed for each traffic participant following its special needs regarding its role (pedestrian, cyclist, motorist) and its characteristics (child, elderly person, disabled persons). Therefore different sensors and actors are needed.

Different research activities exists to realize highly miniaturized and autarkic acting systems (hardware, platforms) using wireless communication. Examples for these research activities are µ-OS such as TinyOS or ContikiOS [5] and e-Grain [6]. Therefore the dimensions of the necessary components for the Sentient Guardian Angel are expected to be very small-sized.

1.4.1 Components of the System

1.4.1.1 Sensors

Sensors are needed for two main reasons. Firstly, to detect the personal behaviour in a certain traffic situation, which is characterized by a “motion vector”. Therefore

- Location (position) and orientation (compass)
- Velocity and acceleration sensors

are needed. Alternatively precise location sensors could be of interest.

Secondly, sensors which detect the presence of other traffic components are required. This could be statical things like traffic signs or traffic control equipment

e.g., traffic lights or dynamical things like other traffic participants. There are two ways of detection. The local detection by

- Noise pattern sensors
- Video pattern sensors
- Ultrasonic sensors

and the intercommunication sensors by active near and medium field communication using active wireless technologies like

- RFID tagging
- IrDA and Bluetooth communication
- Classical RF transmission on an ISM band

1.4.1.2 Actors

Actors are specific to the role and the characteristic of a traffic participant. While motorists will have a specific unit integrated in the car control system with audio and video output the actors of pedestrians should be smoothly integrated in functional clothing. The so called “Active Jacket” could have all components at a sufficient place. Examples are:

- A speaker in the neck for noise alarm and speech output
- Vibration or thermo actors in the sleeves
- Flash lights to warm other traffic participants

One can see that there are two ways of indication, firstly to warn the person itself and secondly to warn others.

In addition, augmented reality technologies can be used for visualisation of alerts or critical situations. Visualization can be done on the windscreen in cars/tram/buses, on visors of helmets and on augmented reality enabled eyeglasses.

1.4.1.3 Wireless communication / Ad-hoc networks

While sensors and actors mainly interact with the local core processor, the wireless communication components are responsible for interaction between traffic participants. “Ad-hoc networks” are build as soon as at minimum two potential entities come into a certain distance. Multiple such threads have to be handled in parallel. Each node in an ad-hoc network is able to act as a router to relay connections or data packets to their destinations. This is necessary if more than two objects are part of the ad-hoc network. Ad-hoc routing protocols are under standardisation.

1.4.1.4 Core processor

While the initial approach relies on a core processor to coordinate sensors, actors and wireless communication components in a second step the local equipment of a traffic participant could be build of a modular sensor network itself. Active jackets could be designed quite easier.

1.4.2 System Operation

As soon as an ad-hoc network connection is established, there will be an exchange of two information:

- The “motion vector”, which allows a prediction of further movements and a calculation of potential crash situations
- The “characteristic set”, which informs about the role and characteristic of the traffic participant

The correlation of two motion vectors allows a prediction of potential crash situations. Therefore any change of one vector has to be reported to the other party. As long as there is no crash course identified, no reaction is required.

The characteristic set has to be exchanged only once between involved parties. It is quite important as children, elderly people and disabled people show quite a specific behaviour within traffic situations. This influences the selection of actors and looks for specific information for the opponent party e.g. a driver could be informed about a deaf person with the intension to cross the road. The local decision finding, implying several steps like “indication”, “warning” and “advise” will be supported adequately.

The power supply of the active jacket will be supported by distributed generators using:

- Temperature differences
- Movements by pressure generation
- Movement by acceleration generations

1.5 Approach

The first step to enable the Sentient Guardian Angel is the development of sensor systems for pedestrians, cyclists and for motorists, respectively the cars. These sensors are able to build ad-hoc networks and exchange information. According to the part of the system (pedestrian or vehicle) the information is evaluated and the sensor system provides the car driver or the pedestrian with warnings of an approaching dangerous situation.

After the establishment of such a sensor system road infrastructure e.g., traffic signs can be integrated by tagging mechanisms. This will help the sentient system to evaluate information regarding the environment of the situation.

As first step it is proposed to start with the requirements of pedestrians having handicaps like deafness. In further steps one might consider other handicaps, elderly persons, children and pets.

The Sentient Guardian Angel is supposed to guard pedestrians. It sends warnings and advices to either the vehicle driver or the pedestrian. Later it could be an assistant e.g., to help a vehicle driver to automatically react in dangerous situations. Additionally, it can become a topic for telematic and navigation aspects regarding vehicle systems.

2 Addition Information

2.1 References

[1] URL: http://www.im.nrw.de/sch/736.htm

[2] URL: http://www.daimlerchrysler.com/dccom/0,,0-5-7165-1-464031-1-0-0-0-0-0-243-7165-0-0-0-0-0-0-0,00.html

[3] URL: http://www.daimlerchrysler.com/dccom/0,,0-5-7182-1-465281-1-0-0-0-0-0-243-7165-0-0-0-0-0-0-0,00.html

[4] URL: http://www.i-wear.com/

[5] URL: http://www.sics.se/

[6] URL : http://www.egrain.org/

2.2 Accompanying Documents

- Flash Demonstration

Please start the flash by double-click.

You can act as an attentive driver by moving the car with the mouse to the left (sorry, continental way of driving ;-))

For the next scene please click on “Next step”.