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RONCALLI TELEMATICS: IN-CAR REAL TIME ROAD-SAFETY INFORMATION

This paper deals with the design and realization of an in-vehicle real time information system for road users using GPS-data and GPRS-communication. RONCALLI telematics is an autonomous working system that delivers real time road safety safety information directly to the driver only where and when it is relevant. The final paper include a detailed description of all available services.

TELEMATYKA RONCALLI: INFORMACJA W SAMOCHODZIE DOTYCZĄCA BEZPIECZEŃSTWA DROGOWEGO W CZASIE RZECZYWISTYM

Niniejszy referat opisuje projekt i realizację pokładowego systemu informacji w czasie rzeczywistym dla użytkowników drogi za pomocą danych GPS i komunikacji GPRS. Telematyka RONCALLI jest autonomicznym systemem dostarczającym informacji drogowej w czasie rzeczywistym kierowcy tylko wtedy i gdzie jest to istotne. Ostateczny referat zawiera opis wszystkich dostępnych usług.

1. INTRODUCTION

1.1. WELL KNOWN PROBLEMS

Road related information is highly dynamic. Traffic signs cannot reflect these high dynamics and therefore do not gain full acceptance by the driver. The validity of many traffic signs is limited by time (Monday to Friday ...) or specific road conditions (snowfall or rain). So the driver has to spend lots of his concentration to properly react on traffic signs. Todays

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In car-Clients provide routing information. Roncalli is a new attempt to bring road safety relevant information to the driver.

1.2. AIM OF THE PROJECTS

To achieve high acceptance of the user the correctness and accuracy of road safety information is a critical issue. In the projects Roncalli and Roncall_I2 the aim was to prototypically demonstrate how this highly dynamically information can be handled and to show the benefits of dynamic road safety information for the user.

Road safety information should be presented

- where it is exactly needed
- only if it is relevant
- with content that is precise and that really matters
- in a way which does not distract

1.3. SYSTEM ARCHITECTURE

The system Roncalli (see Fig.1) consists of two main parts:

- server framework
- in-car client

The server framework consists of the basis-database holding the road network and road safety relevant information (speed limits, traffic signs, road surface characteristics, etc.) and a service database which handles the communication with the client and transforms the raw content of the basis-database into services needed by the in-car client.

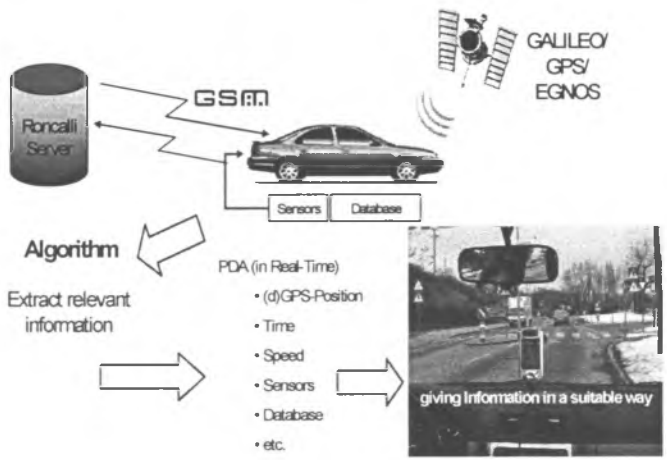

Fig.1. System architecture

The in-car client is a PDA equipped with GPS (position update rate 1 second) or differential GPS (dGPS) if available and GPRS.

The aim was to use only commercially available products – maybe products that are already in use by the driver (like PDA and cell phone) to lower the barrier for interested customers.

No modification of the car is needed.

Additional sensors can be connected via Bluetooth interface. To demonstrate this functionality, a rain sensor was connected to the PDA via a serial port-to-Bluetooth adapter. The GPRS connection is also established via a Bluetooth connected cell phone.

1.4. SERVER AND CLIENT-SERVER COMMUNICATION

All raw content is stored in the basis-database and refers to the reference road network. Because of its limited memory capacity, the client isn't able to hold the complete road network in its own memory. Therefore the reference road network is split in tiles and stored in the service database (see Fig.2).

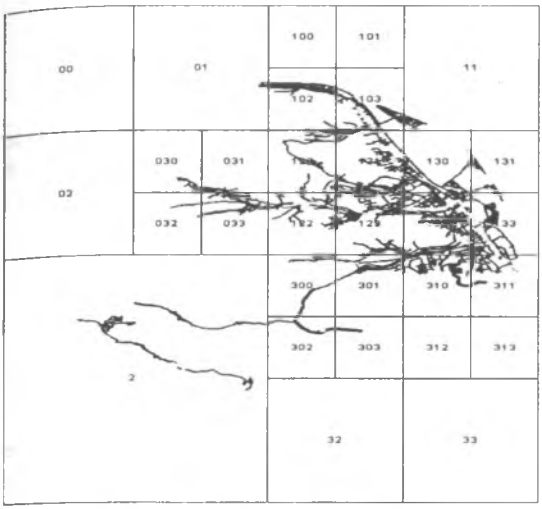

Fig.2. Tiling of road network

Depending on road density, the tiles cover areas ranging from 2x2 to 10x10 km square length approximately. On every modification of the road network (such as changes in speed limits), new versions of the affected tiles are created. The same tiling and versioning is made with the attributes. The client only holds the "home tile" which it is currently in and the surrounding tiles in its memory.

Road network tiles and attribute tiles are dynamically downloaded by the client on every change of the current tile via GPRS.

All data is stored in XML-structures in the service database. Client and server communicate via SOAP (simple object access protocol) [1], the transferred content is compressed via zlib (a very common library used to compress data efficiently) [2], to reduce communication costs.

1.5. CLIENT

The in-vehicle client is a standard PDA (see Fig.3) with a memory extension via SD Card. It receives the current position, speed, heading and time from an attached GPS receiver via serial port or Bluetooth. Furthermore, a rain sensor can be attached via serial port-to-Bluetooth adapter. A GPRS connection to the server can be established via cell phone or integrated modem (dependent on PDA model). The services mentioned below are presented to the user via a simple graphical user interface. Each service is presented at a fixed location on the display with icons easy to understand (mostly regular traffic signs) in order to minimize distraction of the driver. The in-car client follows the principle "No news is good news": All information and warnings are only presented if necessary, i.e. dependent on position, speed and time.

For example, a warning about bad skid resistance is only presented at road elements containing the attribute "bad skid resistance", only when above a certain speed and only in case the rain sensor detects rainfall. To ensure the correct function of the client to the driver, a

small watchdog icon is displayed in the lower left corner of the display that is changing periodically to show the client is "alive" and working.

To detect and show the relevant warnings the following main routine is processed every second:

- get position, speed, heading and time from GPS receiver
- get rain status from rain sensor
- get location on road network (map matching)
- get attributes of current road element
- detect current services dependent on attributes and sensor values
- show current services on PDA display
- play sound if necessary

Furthermore the current tile is checked and neighbour-tiles are dynamically downloaded if necessary. A multi-threaded software design is used to execute the main routine and the downloads parallel. The basic Roncalli services require no user interaction. Everything is done by the client "automatically".

2. RONCALLI-SERVICES

2.1. ISA – INTELLIGENT SPEED ADAPTATION

Intelligent Speed Adaptation (ISA) is a driver assistance system where the current speed limit is displayed at all times. Large scaled experiments concerning ISA were carried out in various countries (Sweden, the Netherlands, United Kingdom) with remarkable good feedback from the test persons. If the driver violates the speed limit, the speed sign begins to blink, changes colour and a sound is played, dependent on the amount of violation.

sensitive areas

accident spots

intelligent speed adaptation (ISA)

skid resistance and ruts

Fig.3. In-car client with Roncalli services

So the "level of annoyance" is increased step by step. Prerequisite for this service is the availability of the current speed limits of the whole road network. The municipality of Klosterneuburg made the required data for the test area available.

A warning for the driver is created

- in case of poor skid resistance
- in case of deep ruts.

2.2. DANGEROUS ROAD CONDITIONS

The warning considers the actual velocity (no warning under 50 km/h and the actual road conditions (only. on wet roads). The road condition is derived from the rain sensor ("rain is on" vs. "rain is off")

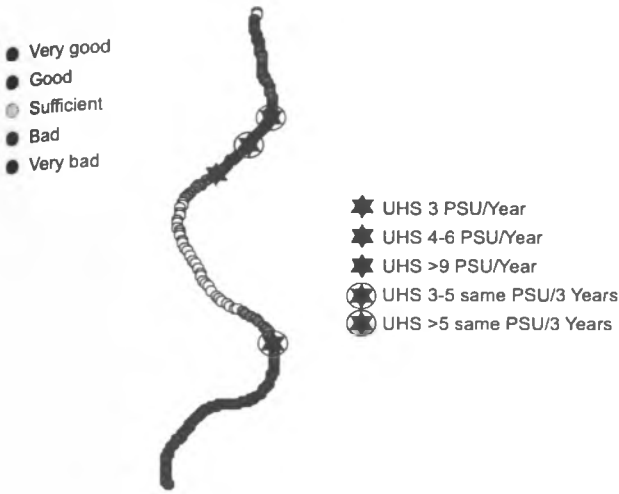

Fig.4. Skid resistance and accidents

Data for the test site were collected by the RoadSTAR (Road Surface Tester of Arsenal Research). Skid resistance and ruts were measured on the high level road network and road sections with constant poor skid resistance and deep ruts were identified (see Fig. 4). These data can also be derived from existing pavement management systems.

The warning symbol is – like the other services – a well-known traffic sign ("Schleudergefahr" – "slippery road").

2.3. ACCIDENT BLACK SPOTS

This service is meant to increase the attention of the driver on sections or points (mostly crossings) of the road network with high accident risk.

The data for this service is derived from the accident statistics maintained by Statistik Austria and was corrected for precise location by the Austrian Road Safety Board – KfV – Kuratorium für Verkehrssicherheit). Every accident involving injury in Austria is recorded by the police. The accidents are centrally aggregated to "Unfallhäufungs-stellen" [3] (sections where more than three injury accidents have occurred in one year, more than three accidents of the same kind in three years, etc).

For the test site, the collected accident data was analyzed in detail. To give only relevant information, the accident circumstances (weather, time of day, driving direction) were analyzed to avoid unnecessary warnings.

There is no specific traffic sign for areas with high accident risk available in the road traffic regulations, so a non-official warning sign for high accident risk used in the Austrian province of Styria was used.

2.4. SENSITIVE AREAS

This service gives the driver a warning about "atypical" road users who afford special attention:

- children
- disabled

The warning is shown near schools, playgrounds, kindergartens or homes of the elderly. Source of the relevant data are the communities who have to determine the relevant areas. The warning is dependent on actual driving speed and on day time (no warning during night), school holidays are also taken into account.

The warning symbol is a well-known traffic sign ("Pedestrians in road ahead").

2.5. ECO-DRIVING

Eco Driving [4] is an accepted measure for reducing fuel consumption and thus CO2 production (estimated 10 percent). This service is an ITS system for teaching and judging eco-driving solely from GPS data.

To calibrate the system, GPS data (position, speed) and data form the car's CAN-bus (fuel consumption) were recorded and analyzed. Two types of parameters were developed to characterize the driving style: The first contains the intenseness of acceleration and deceleration and the second one takes the closeness between accelerations and decelerations into account (therefore called "look ahead"). These parameters are derived from GPS data collected every second. All values were defined as penalties, i.e. the lower the better the more economic. The system was designed to automatically detect section of a ride on the defined stretch (which was chosen to fulfil the criteria of different speed ranges and low traffic jam frequency). This was achieved by having the computer check the passing of 12 virtual check-windows in a defined order. If the defined stretch is detected in a recorded lesson the calculated scores are written into a database and in addition to the score a ranking is produced and displayed. In this way we hope to foster the individual ambition to drive "the economic way" by enabling competition and comparison.

2.6. EXTENDED FLOATING CAR DATA

Extended Floating Car Data is the only service where the user has to get active. The user can generate messages by simply tapping on the touch screen of the PDA. The first tap on the touch screen changes to the extended floating car data screen. There, the user has a quartered screen much like the usual Roncalli user interface, but the icons can be pushed and create messages concerning:

- traffic jam information
- accident information
- weather information
- ...

These messages are delivered to a traffic information center (TIC) and include position, time and heading of the car. The TIC collects the messages, performs integrity checks and generates traffic information that can be delivered via radio, RDS/TMC, Internet etc.

3. RONCALLI MARKET PLACE

During the project Roncall_I2 (successor of Roncalli), the focus was set on establishing a market place for traffic information (see Fig.5).

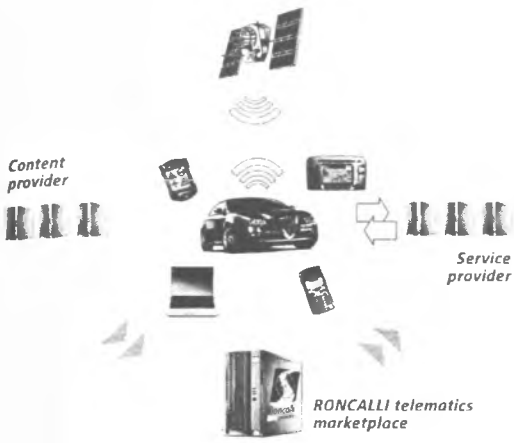

Fig.5. Market place for traffic information

Until now, traffic information was a business-to-business market, mostly from one content provider to one service provider. The aim of Roncall_I2 was to spread the business wider and to enable new telematic services depending on different sources of content. Content providers and service providers are both customers of the market place. The service of the market place is – on the on hand – the provision of a standardized digital road network as reference system and – on the other hand – the clearing and billing of the data traded via the market place.

3.1. INTENDED CUSTOMERS

Customers on this market place are divided into *content providers* and *service providers*. Content provider is every providers of traffic relevant data, for example road authorities, public transport companies and meteorological services. Service providers are companies with the focus on the end user or customer like telecom companies, traffic radio, manufacturers of navigation systems, car manufacturers and so on.

3.2. DIGITAL ROAD NETWORK

A prerequisite for integrated traffic services is a digital road network. Different content providers have located their data in different reference systems. Roncalli aims to integrate different reference systems to simplify the combination of different data sources. Therefore several interfaces were created to deliver georeferenced data to the market place. The benefit of a common reference network is that all data sources are mutually compatible and can be integrated to create services that weren't possible to establish before.

3.3. META DATA

In addition, a Meta database describing the content of each content provider was installed. Traffic data covers a widespread spectrum of characteristics, which are of interest for potential service providers:

- area of coverage, time of last update, update cycle, price
- to name a few. All these data are documented in the Meta database. The Meta database can be accessed and browsed via a website.

4. CONCLUSION

Roncalli and Roncall_I2 try to prototypically show how to deliver relevant road safety information (Roncalli) and traffic data in general (Roncall_I2) to customers. The services of the in-car client aim at increasing road safety for the driver himself, whereas the market place of Roncall_I2 tries to lower the barriers for innovative services not only for in-car clients. The mentioned services could be integrated in navigation systems that not only find the fastest, but also the safest route for the driver. The integration of intermodal services for a client, and – furthermore – intermodal data like delay information and park-and-ride possibilities at the market place will be examined in future projects.

BIBLIOGRAPHY

[1] World Wide Web Consortium. (2004, June 24). SOAP Version 1.2 Part 1: Messaging Framework – W3C Recommendation [Online]. Available: http://www.w3.org/TR/soap12-part1/

[2] P. Deutsch, G. Randers-Pehrson. (1996, May 22). ZLIB Compressed Data Format Specification version 3.3 (RFC 1950). [Online] Available: http://www.gzip.org/zlib/rfc-zlib.html

[3] Österreichische Forschungsgemeinschaft Straße und Verkehr. (2004, August 1). Richtlinien für das Verkehrs- und Straßenwesen (RVS) 1.21

[4] Quality Alliance Eco-Drive (2002, ‚January). Eco Drive Simulator – Facts and Figures. [Online]. Available: http://www.eco-drive.ch/pdf/ff_deutsch.pdf

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