**KEEPING CARS FROM CRASHING THROUGH PERSONAL REAL-TIME EMERGENCY WARNING BASED ON TLC FACILITIES**

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**Summary** – Every minute, on average, at least one person dies in a crash. Auto accidents had injured at least 10 million people in 2001, two or three of them seriously: stormy weather, car accidents, work in progress, queues, can be dramatic for drivers in many ways.

We define Integrated Collision-Avoidance System (InCAS) the system emerging from the integration of collision-avoidance local sub-systems (as ACC, Cooperative ACC, on-road sensors and mobility traffic information servers [3]) with the current telecommunication facilities (GSM, GPRS). We define Personal Emergency Warning the real-time emergency information service supported by InCAS. This value-added service is an assistant that could provide drivers with a significant enhancement of the level of security by means of useful real-time and personalised warnings. Binding between alarms and ringing tones is proposed.

**I. Most Frequent Causes for Collisions**

Every minute, on average, at least one person dies in a crash. Auto accidents had injured at least 10 million people in 2001, two or three of them seriously. All told, the hospital bills, damaged property, and other costs will add up to 1-3 percent of the world gross domestic product, according to the Paris-based Organisation for Economic Cooperation and Development. For the United States alone, the tally will amount to roughly US $200 billion. Figures of crashes statistics in Italy during the last years are reported in next section.

Air bags and seat belts save tens of thousands of people a year. Stepped-up traffic monitoring, police enforcement, or roadway design cannot prevent crashes in poor visibility. More consideration should be given to closing down major highways shrouded in thick fog, just as they’re currently closed when a blizzard occurs. Even though most drivers slow down to some degree, the big problem is getting everyone to drive at a safe, constant speed.

Stormy weather can dramatically reduce the visibility for drivers in many ways. Rain, snow, or fog, coupled with spray kicked up by the cars in front, can all combine to make for conditions where a driver cannot see what is occurring out front at all.

When it is raining hard, visibility becomes even worse. The rain itself, the accumulation of water on your windshield, and the spray kicked up by vehicles in front all make it sometimes impossible for a driver to see anything at all. The best bet is to maintain a very large distance between vehicles so that there is plenty of room to manoeuvre [1].

**II. Crashes Statistics in Italy**

The highway network in Italy is made of private highways (6,473 km), public highways (45,130 Km), district highways (114,422 Km) and municipal highways (141,666 Km).

The average quality is rather good. Nevertheless the number of victims in crashes is increasing while it is decreasing in the rest of UE: this implies there is a serious lack of real-
time emergency information to drivers about bad weather conditions (especially fog) along their path, or car accidents, or work in progress (especially in tunnels).

<table>
<thead>
<tr>
<th>Year</th>
<th>N. accidents</th>
<th>N. dead</th>
<th>N. injured</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>170,702</td>
<td>7,498</td>
<td>240,688</td>
</tr>
<tr>
<td>1992</td>
<td>170,814</td>
<td>7,434</td>
<td>241,094</td>
</tr>
<tr>
<td>1993</td>
<td>153,393</td>
<td>6,645</td>
<td>216,100</td>
</tr>
<tr>
<td>1994</td>
<td>170,679</td>
<td>6,578</td>
<td>239,184</td>
</tr>
<tr>
<td>1995</td>
<td>182,761</td>
<td>6,512</td>
<td>259,571</td>
</tr>
<tr>
<td>1996</td>
<td>190,068</td>
<td>6,193</td>
<td>272,115</td>
</tr>
<tr>
<td>1997</td>
<td>190,031</td>
<td>6,226</td>
<td>270,962</td>
</tr>
<tr>
<td>1998</td>
<td>204,615</td>
<td>6,342</td>
<td>293,842</td>
</tr>
<tr>
<td>1999</td>
<td>219,032</td>
<td>6,633</td>
<td>316,698</td>
</tr>
</tbody>
</table>

Table 1: Statistics of Crashes during the years 1991-1999 [source: ISTAT]

III. Collision-Avoidance Systems: State of the Art

III.1 On-Road Systems

On some freeways have been implemented an automatic fog-signalling system with the aim to elicit safer driving behaviour during fog. On a road section of over 10 kilometres, twenty sensors along the road are continuously measuring the visibility range. During fog, the system displays an explicit fog warning on overhead matrix signs together with a maximum speed limit that depends on the actually available visibility range. An evaluation study in terms of driving behaviour was carried out for a period of over two years. Continuous traffic measurements were obtained at an individual vehicle level from inductive loop detectors at six locations (4 experimental and 2 control locations). Data on the local visibility conditions and on the messages displayed on the matrix signs were available on a one-minute basis.

The results reveal that the system has a positive effect on speed choice in fog: on top of a lower mean speed caused by the reduced visibility itself, the system results in an additional decrease of speed of about 8 to 10 km/h. The system also slightly reduces the standard deviation of the speed. For other measures of driving behaviour, such as following distance, time headway and Time-To-Collision, the system showed small or no effects. The effects found, however, all indicated a behavioural change in a safe direction. It is concluded that the automatic fog-signalling system on these freeways contributes to a safer driving behaviour in fog [1].

III.2 On-Vehicle Systems

The first collision-avoidance features are already on the road, as pricey adaptive cruise control options on a small group of luxury cars. Meanwhile, researchers will be bringing the first cooperative safety systems to market. These will raise active safety technology to the next level, enabling vehicles to communicate and coordinate responses to avoid collisions.

Automakers have already started equipping high-end vehicles with sensors that detect motion and obstacles, coupled to processors that respond instantly to whatever is detected.

These Adaptive Cruise Control (ACC) systems use laser beams or radar to measure the distance from the vehicle they are in to the car ahead and its speed relative to theirs: if a car crosses into the lane ahead, say, and the distance is now less than the present minimum (typically a 1- or 2-second interval of separation), the system applies the brakes, slowing the car. If the leading car speeds up or moves out of the lane, the system opens the throttle until the trailing car has returned to the cruise control speed set by the driver.
The choice of sensor presents classic design tradeoffs. Lidar is less expensive to produce and easier to package but performs poorly in rain and snow. The light beams are narrower than water droplets and snowflakes, pushing down the signal-to-noise ratio in bad weather which is precisely when you need it most. Radar systems, on the other hand, can see at least 150 meters ahead in fog or rain heavy enough to cut the driver’s ability to see down 10 meters or less.

The next generation ACC systems, called Cooperative Adaptive Cruise Control (CACC), is already being tested in US and elsewhere: while ACC can only respond to a difference between its own speed and the speed of the car ahead, cooperative systems will allow two or more cars to communicate and work together to avoid a collision. An experimentation has been conducted by US researchers: they made use of a group of three test vehicles which communicate each to others through a protocol in which the lead car broadcast information about its speed and acceleration to the rest of the group every 20 ms.

Additionally, each car transmitted information about its speed and acceleration to the car behind it. The cars communicate with one another by exchanging radio signals, much as portable electronic devices talk to each other using Bluetooth wireless protocol: when one car pulls up behind another, the two will scan to determine whether the other is equipped for CACC.

However, collision-avoidance is been around for years on big trucks. Trucks take considerably longer than cars to stop and when they crash, they can wreak far greater damage. Each collision-avoidance unit uses radar to detect objects up to 100 meters ahead while other radars on both sides of the truck’s cab pick up objects in the blind spots alongside the vehicle.

A beeper and light-emitting diodes issue different warning levels based on the proximity of the object in the truck’s path [2].

IV. Personal Emergency Warning: Service Aspects

We define Integrated Collision-Avoidance System (InCAS) the system built up from the integration of collision-avoidance local sub-systems (as ACC, CACC, on-road sensors, mobility traffic information servers [3]) with the current telecommunication facilities. We define Personal Emergency Warning the real-time emergency information service supported by InCAS. This value-added service is an assistant that could provide drivers with a significant enhancement of the level of security. Drivers can subscribe to the Assistant Server through traditional procedures (forms and authorisations filled for bank charging) without any fee, at least in early deployments (in order to maximise the number of customers). Each user profile (e.g. which kind of terminal and the related address could be available in order to receive emergency warnings) is stored into a server at the Control Centre (see fig. 1).

The Personal Emergency Warning will give real-time warnings on driver’s neighbourhood about:

- a. Bad weather condition (presence of fog, rain, snow, wind, …)
- b. Crashes (especially in tunnels)
- c. Work in progress (especially in tunnels)
- d. Queues (especially in tunnels)

The proposed assistant can significantly lower the number of crashes due to real-time personalised warnings provided directly to drivers via mobile terminals.

Mobile operators as well as Service Providers should be interested in providing the Personal Emergency Warning service for several reasons, e.g. the very large number of potential customers who could generate huge quantity of new information traffic and the possibility to enter this business in partnerships with content providers / highway operators in order to get revenues from increased value of carried information.
Moreover the incoming 3G systems, as GPRS and UMTS, will be powerful enablers for the telecommunication component of InCAS: the availability of a wider bandwidth for 3G network infrastructures and the man-machine interface enhancement, i.e. enlarged displays, for 3G mobile terminals will allow richer content (especially maps) to be transferred to customers. The grade of interactivity between the customer and the service would be increased thanks to more friendly interface and the adoption of pictures and icons.

V. Personal Emergency Warning: Access Aspects

The Personal Emergency Warning can be supported by the Assistant Server and accessed by customers through a multi-channel portal: each channel corresponds to an information medium so that several kind of terminals, as mobile phones, Car Navigators, notebooks and whatever else, can access the Assistant. Mobile phones assure the interactivity by Short Messages over GSM or by browsing through a WAP interface (when terminal is WAP-enabled) or by means of IVR (Interactive Voice Recogniser) primitives at the server side. Car Navigators or whatever advanced mobile terminals assure the interactivity by Web-based interfaces towards vectorial maps.

VI. Personal Emergency Warning: System Aspects

The proposed Personal Emergency Warning is fed with the information provided by InCAS.

Let us consider the functional architecture depicted in fig.1: InCAS is the integration/aggregation of various collision-avoidance local sub-systems with telecommunication facilities. In this way each sub-system can provide a component of the overall information delivered to drivers (see info flows a, b, c, d, e in fig.1):

a. If available, the on-vehicle GPS receiver can provide the location information about the vehicle itself to the Control Centre via GSM/TETRA
b. If available, the on-vehicle ACC / CACC systems can provide additional information about the local traffic situation (queues, heavy traffic) to the Control Centre via GSM/TETRA
c. Crashes information can be provided by witnesses or by the drivers themselves to the Control Call Centre via toll-free phone numbers
d. Weather information can be provided to the Control Centre via dedicated fixed lines (or GSM/TETRA if such information is not too heavy) by means of ad-hoc sensors placed along highways (or, at least, nearby localities where unfavourable climatic phenomena show their most intensity).
e. Additional mobility information, especially in metropolitan area, can be provided by the Mobility Assistant Server [3] to the Control Centre via dedicated fixed lines.

Subscribers can access the Assistant through the multi-channel portal.

All information from InCAS system is collected by the Aggregation Server and stored into a suited database and the Data Processor Server queries, processes and formats aggregated information as required by the users. The Service Server, which drives a database where are stored all users’ profiles, automatically distributes the information to drivers according to the available terminals (e.g. a GSM terminal could receive information via Short Messages or Vocal Messages, a PDA terminal could receive information via e-mail). The Call Center could integrate the Service Server for those emergency cases, or when the Service Server is out, through traditional GSM-phone calls.

The proposed value-added feature is the possibility to bind a ring tone dependently to the emergency warning in order the driver be just real-time informed about it leaving the
details to a further reading. This will avoid any driver’s lack of attention during information acquisition.

VII. Personal Emergency Warning: Feasibility Study and Demonstration Step on the Road

InCAS system is a research proposal for a real enhancement in secure driving and crashes avoidance. We propose a demonstration of InCAS and the support of the Personal Emergency Warning. Fig. 2 represents a Feasibility Study according to defined steps: items and possible interested player categories are included. The output of the Feasibility Study will be the dimensioning specifications of a demonstration site and planning the relevant activities to acquire the basic and common know-how indispensable for the next experimentation on the road, aimed to final testing, technical validation, evaluation of human and cultural impact of the proposed InCAS system. It is important to underline that similar research and demonstration programs are foreseen in 2002-2004 business plans of certain highways operators [4].

VIII. Conclusions

The introduction and deployment of new telecommunication technologies for security driving along highways can play a central role in the society: several lives could be saved. Nevertheless all those new services and applications that can have an huge impact on the daily life of a people community are often barred by strong cultural barriers and by an
insufficient civic diligence (crash witnesses should phone to a toll-free number in order to indicate at least the location of the crash).

Often it occurs that new technologies are at citizens’ disposal but they hardly will use them. In most cases the fault can be found in a lack of advertisements towards citizens, but cultural resistance is always under the corner.

Moreover it is important to note that even the more advanced technology could do nothing against negligence and carelessness in the driving behaviour!

![Diagram showing items and players for InCAS Demonstration]

**Fig. 2 – Items and Players for InCAS Demonstration**

### IX. References