

## **DESIGN OF ON-LINE DRIVER ASSISTANCE SATELLITE OBSERVATION SYSTEM (SOS)**

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### ***Abstract***

*The article describes the design of a Satellite Observation System (SOS) which assists drivers in their travel (in real time). The system allows the driver to receive a top-down view (in the respective scale) covering a large area around their vehicle. Using the GPS and the GSM system as well as images from a satellite – thanks to the SOS, the driver will be provided with a valuable tool assisting them in driving e.g. when: overtaking in heavy field conditions, identification of the road or facilities, setting a more optimal route (bypassing traffic jams) etc.. The principle of operation is based on respectively located satellites which take very high-resolution pictures of the Earth's surface in real time. These pictures are sent via the GSM (or a different) system to the receiver of the SOS system on the ground - a SOS station - which projects GPS coordinates on them. In order to receive the image with the area of the road ahead (or around the vehicle), the driver in a vehicle turns on their SOS system which sends the vehicle's GPS coordinates to the SOS station. The SOS station processes the picture received from the satellite, preparing only a small section of it which corresponds to the area around the GPS coordinates – the vehicle's position. This section is then sent to the SOS system inside the vehicle, which, in turn, displays it on an LCD screen. This cycle repeats so rapidly that the driver may be under an impression that he/she watches the image from the camera placed over the vehicle. The SOS system will contribute to the increase in road safety and the maneuver of overtaking in difficult field conditions will become less risky. The SOS system will also allow the emergency services and the police to promptly locate and identify any road accidents.*

**Keywords:** SOS satellite observation system, ground SOS station, vision-telecommunication satellite, overtaking, GPS coordinates GSM system, road safety

### **1. Introduction**

Safety of vehicles on roads is one of the priorities which have been the subject of the works of multiple scientific centres. Various systems are being developed: protective (safety belts, airbags), traction control (ABS, ESP, DSR), warning (LDW, parking sensors), notifying about the collision (eCall) etc.

Common operation of many of them is used in practice, since each is responsible for a different safety aspect. Safety systems are divided into active and passive. They can also be divided into: preventing systems (before the accident), active systems (active during the collision) and shielding systems (limiting the effects of the accident). Such a division has been included in Tab. 1.

Tab. 1. Division of vehicle safety systems

Type of the system	Examples
<b>Preventing</b> (before the accident)	LDW, parking sensors, SOS
<b>Active</b> (during the collision)	Safety belts, airbags, ABS, ESP, DSR
<b>Shielding</b> (after the accident)	eCall, SOS

The accident preventing systems are, first for all, systems warning against possible occurrence of hazards (LDW) or assisting the driver (parking sensors, SOS).

The active systems act when a hazard has appeared or during the collision by automatically limiting possible damage by elimination of the human factor (ABS, ESP, DSR) and frequently saving human life (safety belts, airbags). In the event of a threat of e.g. skid, these systems are often able to completely protect the driver against the effects of the threat.

The shielding systems, which act after the accident, are mainly associated with limitation of damage related to the new situation by notifying the relevant emergency services as soon as possible (eCall, SOS). Apart from saving health and lives, these systems may contribute to limitation of the hazards associated with contamination or pollution of the environment (in the case of e.g. a collision involving a tanker with harmful chemicals).

The eCall collision notification system is an on-board device capable of detection of a road collision and automatic summoning of assistance to the place of the event. The eCall device, equipped with an acceleration sensor, continuously analyses the data concerning its value along the lengthwise and transverse geometrical axis of the vehicle. Should an acceleration exceeding the programmed limits be detected, the procedure of notification of the event to the Emergency Notification Centre will be activated [1].

The **SOS** system has been entered to Tab. 1 as both the preventing and the shielding one. The SOS is an on-line Driver Assistance Satellite Observation System (Pol. System Obserwacji Satelitarnej).

## 2. Principle of operation of the SOS system

The SOS system assists drivers in their travel (in real time). It allows to receive a top-down view (in the respective scale) covering a large area around a vehicle in motion. Using the GPS and the GSM system as well as the images from a satellite – thanks to the SOS, the driver will be provided with a valuable tool assisting them in driving e.g. during: overtaking in heavy field conditions, identification of the road or facilities, setting a more optimal route (bypassing traffic jams) etc.

The principle of operation of the system (Fig. 1.) is based on respectively located vision-telecommunication satellites (Fig. 1. A) which take very high-resolution pictures of the Earth's surface in real time. These pictures are sent via the GSM system (or another e.g. Wi-Fi) to the receiver of the SOS system on the ground - the SOS station (Fig. 1. B) - which projects GPS coordinates on them.

In order to receive the image with the area of the road ahead (or around the vehicle), the driver in the vehicle (Fig. 1. C) turns on their SOS communicator which sends the vehicle's GPS coordinates to the SOS station. The SOS station processes the picture received from the satellite, preparing only a small section of it which corresponds to the area around the GPS coordinates – the vehicle's position. This section is then sent to the SOS communicator inside the vehicle, which, in turn, displays it on an LCD screen. This cycle repeats so rapidly that the driver gets an impression that he/she watches the image from the camera placed over the vehicle.

The SOS system will contribute to the increase in road safety and the maneuver of overtaking in difficult field conditions will become less risky. The SOS system will also allow the emergency services and the police to promptly locate and identify any road accidents.

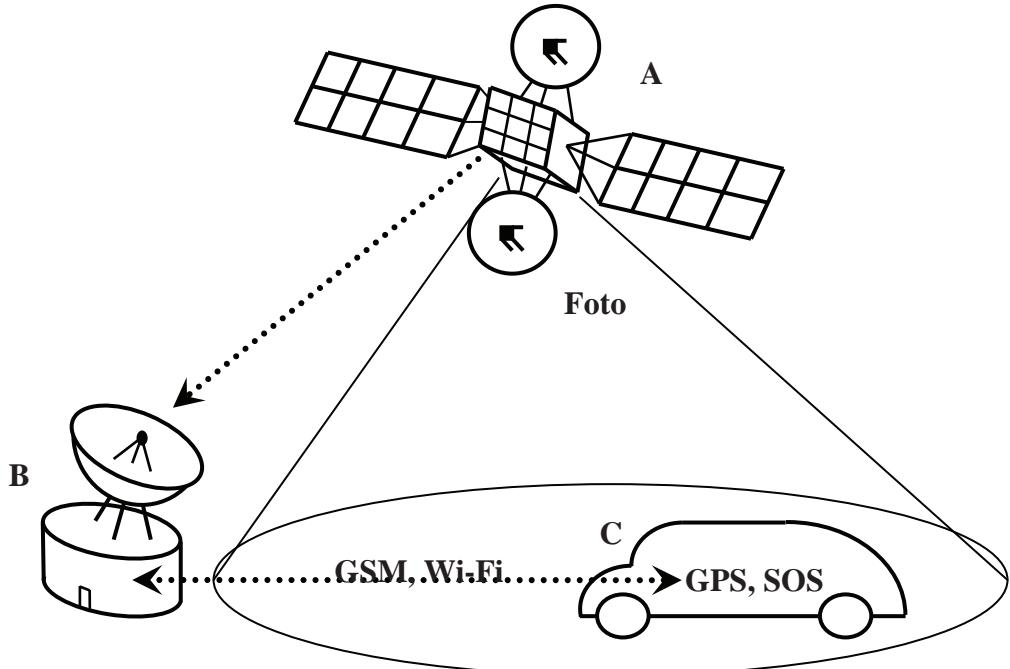


Fig. 1. Principle of operation of the SOS system

### 3. Components of the system

The components of the SOS system are, first of all, the accordingly located vision-telecommunication satellites, ground SOS stations as well equipment of vehicles in the GPS system, the GSM (or Wi-Fi) system and a SOS communicator (Fig. 1.).

#### 3.1. Vision-telecommunication satellites

Vision-telecommunication satellites (Fig. 1. A) should be located in a manner that allows them to cover the entire target operation area , e.g. Europe, with the range of pictures taken by them. It would be preferable if each section of those areas could be selected interchangeably from two or more satellites. In this way it will be possible to receive a good image even when there are small clouds in the sky.

The device taking the pictures should have very high resolution, which will provide high sharpness of image even at respectively large magnification of a small section from the whole area. Pictures should be taken quickly and sent on-line to the ground SOS stations.

#### 3.2. Ground SOS stations

The ground stations SOS receiving stations (Fig. 1. B) receive pictures sent on-line from vision-telecommunication satellites and then, having received the GPS coordinates from the vehicle's SOS communicator, send the vehicle only the selected, enlarged section of the picture which is associated with the surface around the GPS coordinates' position.

#### 3.3. Vehicle equipment

The vehicle (Fig. 1. C) must be equipped with the GPS system and have a SOS communicator with a LCD display. After switching on the SOS communicator inside the vehicle, it determines its location by sending GPS coordinates via the GSM (or Wi-Fi) transmission to a ground SOS station.

From the ground SOS station, the SOS communicator receives the section of the picture which corresponds to the area around the sent GPS coordinates, which is then displayed on the LCD display of the driver's SOS communicator.

It is enough for the driver to have a look or two at the LCD screen to learn the situation in front of the vehicle and respond accordingly (as is the case when looking at the rear-view mirror).

#### 4. Advantages and disadvantages of the SOS system

Advantages of the SOS system:

- Possibility of observation of the road around and in front of the vehicle (assessment of traffic intensity in front of the vehicle, around turns or other field difficulties).
- Significant facilitation in overtaking (all vehicles approaching from the opposite direction can be seen, especially if the driver of a low passenger car wants overtake a lorry or overtakes a different vehicle in a mountain or a curvy area).
- Determination or identification of the route and finding facilities (as on a map, e.g. exits from motorways, petrol stations, inns, stopovers etc.)
- Possibility of choosing a detour and determination of a new route during high traffic intensity in cities (traffic jams, repairs, other hindrances).
- Possibility of fast reporting of road accidents and precise view of the hazard condition. The relevant services can monitor roads and, in the case of receiving information about a road accident, carry out a remote visual inspection and estimate e.g. how many ambulances should be sent, which equipment should be taken and which services should be sent to the place of the accident.

Disadvantages of the SOS system:

- The relevant instrumentation is necessary both in the vehicle (GPS GSM, a SOS communicator) and on the outside (a system of vision-telecommunication satellites, ground SOS stations).
- The SOS system would work only in good visibility. Night time or cloudy sky would preclude using it. However, such difficulties could be solved by application of infrared cameras or night-vision devices (night) as well as selection of images from several satellites which simultaneously cover a given section land (clouds).

#### 5. Summary

The SOS system would be undoubtedly a supporting system and would be extremely useful for each driver. Thanks to it, carrying out one of the most common maneuvers – overtaking – would not involve high risk, as it has so far, especially in difficult field conditions.

The system would also significantly contribute to decreasing traffic congestion in cities. Drivers would be able to choose different passage routes so as to bypass forming traffic jams.

Implementation of such system would also facilitate the work of all emergency services. By monitoring the size of a collision directly, they would be able to assess the importance of the threat more precisely and rapidly take appropriate life-saving steps.

#### References

- [1] Kamiński, T., Mitraszewska, I., Nowacki, G., Niezgoda, M., Ucińska, M., Filipek, P., *Traffic collision detection for the needs of an on-board ecall device*, Transcomp, 2010.