SYSTEM AFFORDING SAFETY AT ROAD SITUATIONS

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In this paper the basic methods to compute safe driving and assist the driver are suggested. The software and hardware requirements to construct a reliable and trustworthy system are stated.

Keywords: driverless car, safe driving interval, control system, overtake, road adhesion.

The usage of external devices that facilitate driving is one of the leading trends in the automobile industry. Most of the companies in this business are delving into research in this field, although these projects are not developed enough and are somewhat costly to implement on the consumer market. We should mention that the usage of the simplest microelectronics could lower the mortality rate, while using the safe modes on these devices. Such systems could be developed rather quick and installed on new and old vehicles.

The goal of this paper is algorithm development and means of soft- and hardware development (DH-ITS), which could assist the driver the intervals to the front, back and the rear drivers near the vehicle and calculate the probability of the safe overtakes. Formulae [1, 2] are used for such calculations.

DH-ITS requires the installation of additional hardware on the vehicles that use this system and transmit data using short wave frequencies.

Short waves usage lets vehicles communicate through small obstacles and in bad weather conditions. DH-ITS messages contain:
Car ID, GPS coordinates, speed, vehicle information, road condition and weather condition.

Using the received data and internal sensors, the internal computer calculates the values below and displays them to the driver:

1. Safe distance to the front car:

$$D_6 = \frac{(t_1 + t_2 + 0.5t_3)\cdot v_2}{3.6} + \left|\frac{v_2^2 - v_1^2}{26\cdot I_\Gamma}\right| \quad (1)$$

Where:
t1 – driver's reaction time;
t2 – brake action time;
t3 – brake time;
v1, v2 – speeds of frond and back cars;
$I_г$ – slowdown coefficient during brake [2].

$$I_\Gamma = \frac{g\cdot\varphi}{K_e} \quad (2)$$

Where:

$g = 9.81\frac{m}{s^2}$, K_e=1.3 – brake action effect quality coefficient, road-vehicle adhesion

2. Safe rear interval to the oncoming car and the passing car [2]:

$$X_в = 1.0 + 0.005(V1 + V2) \quad (3)$$

$$X_п = 0.7 + 0.005(V1 + V2) \quad (4)$$

Values V_1 V_2 are the safe velocities of cars which require the calculation of a safe rear interval.
Where:
$X_в$ – rear interval of other car moving towards our driver's car,

$X_п$ – rear interval with cars moving with our driver's direction.

3. Safe interval of continuous driving
4. The opportunity and parameters of overtake assumes these two steps [2]:

Step 1: vehicles retrieve their GPS coordinates
Step 2: detection of other vehicles

FM transmitters of all cars issue their coordinates (x_k, y_k), speed (V_k), length (L_k) and ID (ID_k) on a given frequency. Vehicle #0 also transmits this data. After other vehicles transmit the data, vehicle #0 receives it and passes it to the internal controllers of the system.

The first controller forms the array of vehicles in the 1 kilometer radius. (A an array of cars) Every member of this array is a cortege of [ID_k, V_k, x_k, y_k, L_k].

The second controller identifies the id of the nearest vehicle in front of vehicle # 0. Controller does it by forming the same array as before and calculates the nearest distance from the vehicles on the same lane to the $vehicle_0$. This distance is called CARnext in this system.

```
If ((yk> y0) && (xk> = x0))
{Sk = yk - y0 - errorGPS // distance to vehicle_k }
```

Controller #2 transmits the found ID to controller #1 after this step.

Step 3: coordinate system building

Controller#1 build their own coordinate system in the center of the car (x_0 Xcenter, y_0) Xcenter – distance from vehicle#0 to the division strip.

Step 4: overtake opportunity check

1. If a behind vehicle began the overtaking process, inform the driver that overtake is impossible.

```
If ((xk <x0) && (yk <y0))
{Message «No overtake opportunity» Speeding limited}
```

2. Computing the distance and ID of the onwards vehicle on the opposite lane with GPS error

```
if ((xk <x0) && (yk> y0))
{S = yk - y0 - errorGPS;
IDopposite = IDk;}
```

3. Computing collision time between vehicle#0 and vehicle on the opposite lane

t = S / (V0 + Vopposite)

4. Computing overtake opportunity

```
If (((V0 + a0 * t) * t + L0)> Lnext + Vnext * t) && ((V0 + a0 * t) * t + L0) <S))
{Message «Overtake possible»}
else {Message  «Overtake restricted»}
```

Conclusion: we calculated the basic methods to compute the driving and their algorithms in this report, pointed out the hardware requirements which let to engineer such a system.

SOURCES

1. G.Branihin, Extreme driving - Publishing house "Peter", 17 September. 2007
2. G.Osipov , Methods of artificial intelligence 12 January 2017.

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System affording safety at road situations

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