Research Paper Engineering

Proposal for the Implementation of a System Detecting People In Vehicle

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ABSTRACT

The objective of the article is to describe the equipment of a state-of-art vehicle with a passive people detection system. The detection is based on IR cameras installed in the vehicle interior. The system can identify the exact number of people in the car, distinguish adult persons from children and identify the driver. Moreover, the system goes with a RFID card reader that requires an active cooperation of passengers but it makes it possible to report to the system some other information such as passenger´s handicap, serious sickness or blood group. The system may be integrated to Smart Cities applications or eCall system.

KEYWORDS Detection of people, Smart Cities, eCall, IR camera, RFID

INTRODUCTION

The issue of the detection of people and identification of the exact number of people in vehicles becomes more important in the framework of Smart Cities and with the implementation of smart technologies. This issue is relevant for instance when making use preference driving lanes in cities, car sharing or use of smart park houses. The information on the exact number of passengers may be used also in the eCall system as under development (emergency calls) in the EU framework [1][4].

PROPOSED SYSTEM FUNCTIONALITIES

The 3K system consists of 3 independent functional units:

1. Automatic detection of the number of people in the vehicle including distinguishing of adult persons and children
2. Automatic identification of the vehicle driver
3. Health and other information acquired with the active involvement of passengers

Automatic DETECTION OF PEOPLE

The 3K system defines the number of passengers by thermal imagers deployed in the vehicle interior. The system will allow for exact detection of the number of people in the vehicle both day and night, the imager will distinguish people from any cargo items [2].

Human face is scanned using contact-free thermography. Human organism is capable of very exact thermal regulation of its own body temperature. Thank to this, we are able to detect human face and distinguish it from any artificial background. The thermal imager works on the basis of contact-free temperature field measurement. Fields are recorded to a 2D matrix. The measurement principle [3] is based on recording of thermal irradiation from the face surface. This thermal irradiation gets through the imager optic system to the detector where it gets converted to electrical signal that is digitalised in the next step and processed in order to show the resulting face thermogram. See Fig. 1.

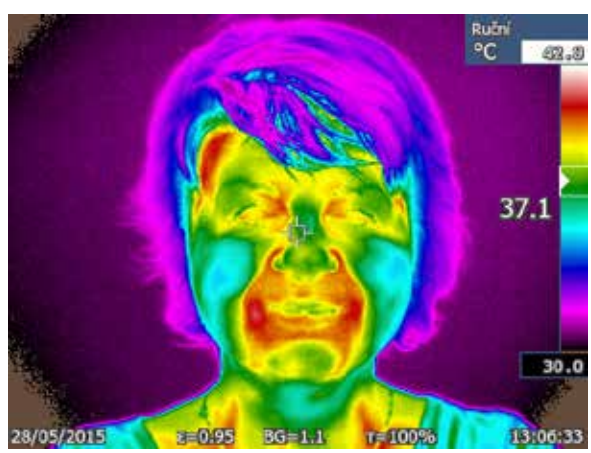

Figure 1: Driver´s thermogram

The thermogram includes information of the distribution of temperatures on the face surface. In the next step, an algorithm detecting face shape in the given thermogram is implemented. Children face geometric features ratio differs from adult person features and it is shown by differences in the thermogram.

Face is detected and localised by sub-space statistically oriented methods. This method is supposed to find general but typical characteristics in the thermogram (e.g. shapes – eyes, nose, mouth) that are typical of human face. If such characteristic features are found, the system concludes that it is a human face. Each face shape is considered a multi-dimension vector and each pixel matches a certain image component. If all face typical features are located in the same sub-space of the multi-dimensional space, such a sub-space is a representation of human face (as it includes common face features). The

face detection is then detection of this sub-space.

Automatic vehicle driver´s identification
The automatic detection of the vehicle´ s driver makes it possible to identify the driver based on 3D face identification. The algorithm is based on the Elastic bunch graph matching (EBGM) (Fig. 2). What could be used as an option is the driver´s identification based on his/her iris, fingerprint, skin spectrometry or finger (index finger) blood vein system) which would, however, require installation of another biometric scanner.

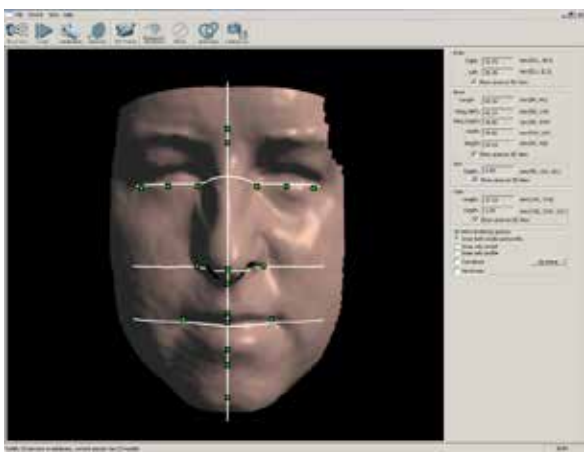

Figure 2: Automatic identification

ID CARD BASED INFORMATION
The 3K system makes it possible to use ID cards equipped with a RFID chip to transfer other information on vehicle passengers to ExOBU. It provides information on handicap, serious illness, blood group, pregnancy etc.

The system requires an active involvement of the passenger by means of attaching his/her ID car with required information to the RFID reader.

VEHICLE HW EXTENSION
The implementation of the 3K system (Fig. 3) is subject to extension of the car technical equipment with an external OBU (ExOBU) that is designed to store and evaluate data from the systems installed in the vehicle and its electronic systems.

- **Communication with electronic system**

In the car, the ExOBU communicates with the CIS (Car Information System) from where it uploads such data such as acceleration/deceleration of the vehicle, interior/exterior temperature and other operational data concerning the trip and other significant events.

- **Communication with external systems installed inside the vehicle**

The ExOBU is interconnected with IR cameras installed inside the vehicle for the detection of the number of people and driver´s identification. The other system connected to ExOBU is the RFID reader.

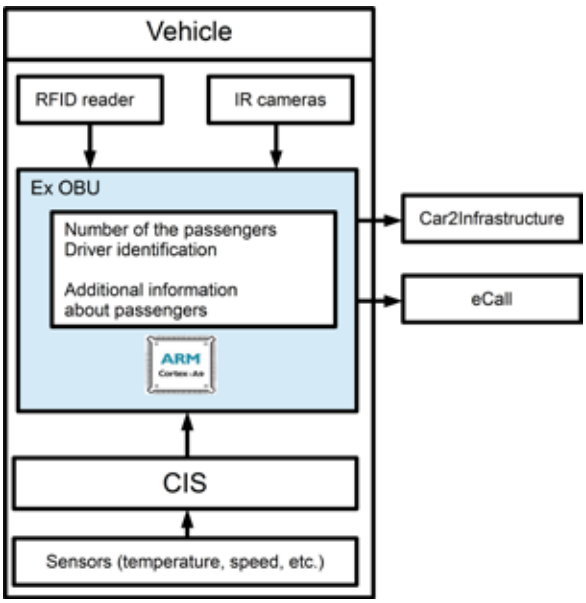

Figure 3: 3K system block diagram

IR CAMERAS
Identification of installed thermal imagers:
- Measurement accuracy ± 2 °C
- Display definition 0.1 °C
- Temperature definition <= 0.05 °C

When detecting human face in the vehicle, differences between the human face temperature and environment temperature may disappear under certain thermal conditions. This is why the installed thermal imager type plays an important role and in particular the parameter of temperature sensitivity called NETD (noise equivalent temperature difference). The setting of the temperature range depends on the interior temperature inside the vehicle which may be a limiting condition for the thermal imager application as a driver´ s face identification tool. What is set when locating face on the thermogram as the optimal temperature scope for simplification is the interval – 10 °c to 45 °C.

Several options of the deployment and number of IR cameras in the vehicle were tested during the implementation of the system. What proved to be the most convenient solution are 4 IR cameras installed at the left-hand and right-hand side of the vehicle at the front and rear column (Fig. 4).

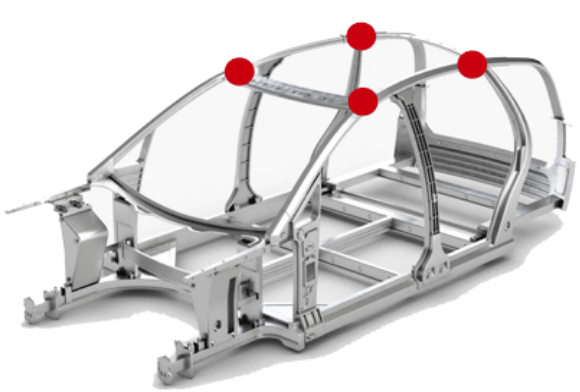

Figure 4: Deployment of IR cameras in the vehicle.

CONCLUSIONS

The article describes the possibility of the extension of the state-of-art vehicle system by including some new smart functions. The proposed 3K system makes it possible to detect the number of people, identify the driver and transfer other useful information to the eCall system or Smart Cities applications using own designed ExOBU.

At the time being, we are testing standard cameras with IR additional lighting in the 3K system because of lower purchasing costs. The temperature imagers were the first choice method in order to recognize live face based on specific body temperature and to distinguish it from its copy.

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