Lucerne University of
Applied Sciences and Arts

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CC Innovation in Intelligent Multimedia Sensor Networks (IIMSN)

Devise4CCTV – Video-based person counting for mobile applications

Infrared-sensor based people counting systems in buses or trains are a common tool for the operators to collect information on passenger statistics and the results are even used – especially in case of train-sharing among different transportation companies ("Verbundverkehr") – for billing purposes.

In addition, during recent years train and bus operators started to deploy CCTV equipment on their rolling stock with the goal to improve passenger safety and to reduce damage or degradation caused by vandalism. Obviously it would be of great interest for the operators if person detection and counting functionality could be taken over by the CCTV system. However, even though the first concepts for video based person counting have been developed more than a decade ago and since then many approaches have been realized and are commercially available now, the use of video-based passenger counting in mobile application has only been investigated in few cases. And, to our knowledge, no running commercial realization is available on the CCTV market.

The main reason for that are the environmental conditions in mobile environments, which are very harsh due to quickly changing illumination conditions and high intra-scenic contrast. Standard CCD cameras have difficulties to cope with these conditions and saturation and blooming effects considerably reduce the quality of the acquired image data. Furthermore, the vast majority of video-based person counting approaches work with cameras in overhead positions. However, this geometry is difficult to realize in the low entrances of buses or trains doors and cameras are usually installed showing frontal view of the boarding passengers. Here the combination of the high dynamic range DEVISE[1]-imager with the appropriate Video Content Analysis (VCA) concepts developed at the CC IIMSN is a promising approach to solve these problems.

The DEVISE-platform is a cutting-edge technology in the area of System on Chips (SoC). The contained CMOS-imager combines image acquisition capabilities with low-level image pre-processing aiming specifically on robust object recognition and classification applications. The processing includes (Figure

[1] Developed at the CSEM (www.csem.ch)
[2] Image with courtesy from CSEM

Project
InViNe

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Project Management:
Dr. Klaus Zahn, CC IIMSN

Contact

Hochschule Luzern
Technik & Architektur
Technikumstrasse 21
CH-6048 Horw

Dr. Klaus Zahn
T +41 41 349 35 73
klaus.zahn@hslu.ch

www.hslu.ch/technik-architektur

1, from left to right):

- auto-exposure at the pixel level with an intra-scenic dynamic range of 130 dB;
- contrast extraction for very robust and sensitive object extraction;
- direction of contrast extraction for feature classification;

The left image of Figure 1[2] shows the full potential of the high dynamic range vision sensor: the entire image starting from the filament of the light bulb up to the darker outer regions of the lamp are shown without any saturation or blooming effects. E.g. it is even possible to read the information sticker on the lower inner side of the lamp.

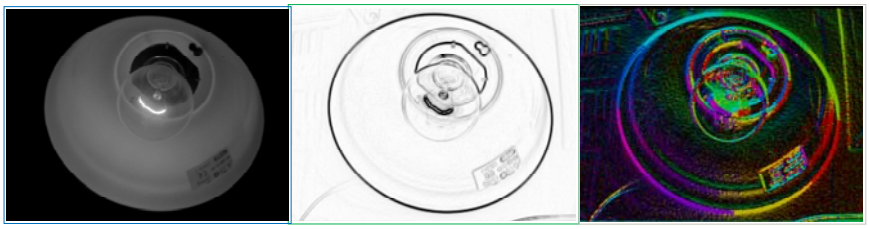

Figure 1: *Devise platform images: log of the luminance (left), contrast magnitude (centre), contrast direction (right)*

The remaining two images show the contrast magnitude (centre) and contrast direction (right, represented in pseudo colour code). This information – calculated directly on the DEVISE-imager (SoC) itself – will be directly used as input to the VCA algorithms for the detection and tracking of the objects in the scene.

The VCA algorithms will be based on methods developed within the CC IIMSN using a three step approach consisting of an object extraction, an object tracking and an object classification step. This is demonstrated in Figure 2 (from left to right) using an example taken from a traffic analysis application. For the primary VCA processing step (left) – the object extraction – we chose very robust methods based on magnitude and directional analysis of the image contrast information. The pseudo colour codes represent the contrast directions similar to Figure 1. As this information is already calculated directly on the vision sensor itself (SoC) we can make directly use of it and considerable processing resources on the upper processing layers will be saved.

Figure 2: *Video Content Analysis: object extraction (left), object tracking (centre), objet classification (right)*

The first major goal of the project DEVISE4CCTV will be to evaluate the potential of the high dynamic range DEVISE-

camera platform for demanding – in terms of environmental illumination conditions – VCA applications in the market of CCTV. As outlined above these demanding applications are most likely to be found in mobile environments as on buses and/or trains. As an example application the counting of passengers boarding or leaving the bus/train will be implemented and the advantage of the DEVISE-platform with respect to the use of a conventional CCD vision sensor will be demonstrated. The underlying algorithmic concepts and their implementation could, nevertheless, be used in other applications in the area of CCTV surveillance.

For practical implementation purposes it is also of major importance to demonstrate, that the developed algorithmic concepts can be hosted by an appropriate processor platform. As the ultimate goal of the present project is the design of a hardware platform suited for mobile applications a second goal will be to evaluate and choose an appropriate processor platform. Here the fact that part of the VCA pre-processing is already provided (as SoC) on the DEVISE-imager and processing resources on the higher-level processing platforms can be saved will be beneficial. The choice of the processor platform shall be optimal in the sense that the system with the least but yet sufficient processing power is used.

The project will start with a data acquisition phase where video streams, acquired simultaneously with the DEVISE-imager and a state-of-the-art CCD-imager, will be recorded for further evaluation purposes. Based on this data and our existing VCA know-how specifically optimized algorithms for the purpose of person detection and passenger counting will be developed and tested. Then a performance comparison DEVISE- to CCD-imager will be performed. Finally the software will be ported to and its performance be evaluated on different processor platforms to demonstrate the feasibility of a “low-cost” hardware platform for mobile applications.

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