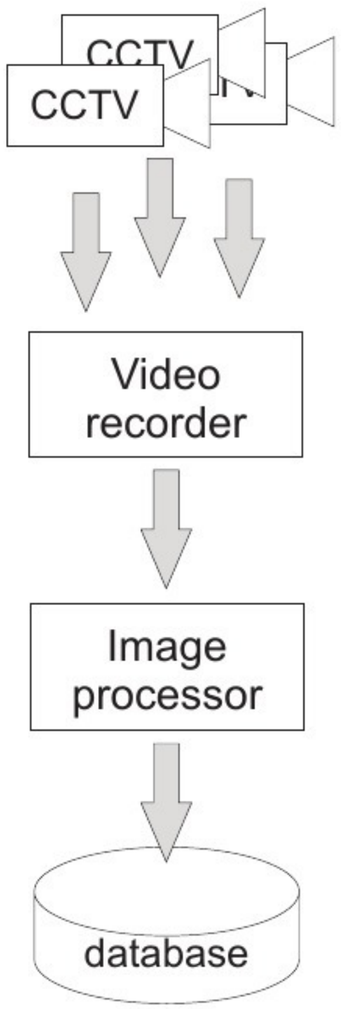
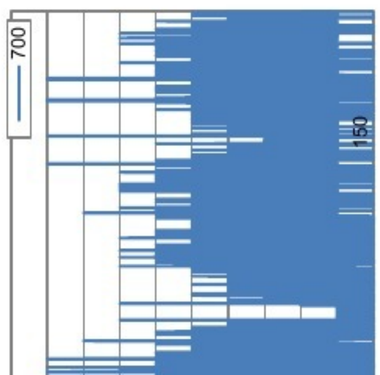


Figure 5: Gathering count of persons out of the camera images.



extraction algorithm can fail. In these cases, the algorithm returns the error value "-1".

The extracted count of passenger as well as date, time and the camera-ID of the image are transmitted to the database. The general approach is depicted in Figure 5.

The CCTV system as well as the image processing running 24 hours, 7 days a week. Each day 28800 datasets are transmitted to the database. Overall the database contains 90 days of data. The available data are discussed in the next section.

Count of persons data

Properties of the data

In order to model the passenger density an understanding of the available data is necessary. In this section the data, visible pattern and other features are discussed.

Figure 6 illustrates exemplary the available values of a camera and week. The PdG service times are visible due to the low passenger density level between 01:00 and 05:00 on weekdays.

Prediction by Artificial Neural Fuzzy Inference System

Conclusion

In this paper we have dicusssed ongoing work in the SEAM4US project. In particular, we have discussed peculiarities of the Barcelona underground system under observation. This has in particular shown that there are plenty of CCTV sensors installed in underground metro systems which are capable to generate enormous amounts of feature data which can be utilised, for instance, for the analysis and prediction of passenger density over time. In particular, we could observe that, although the magnitude of passenger density fluctuation differs depending on where in the system the corresponding cameras are installed, this fluctuation is highly correlated among the CCTV sensors. Furthermore, the data shows clear patterns that allow prediction of passenger density over time. We have therefore investigated the predictability with an Artificial Neural Fuzzy Inference System which as shown good potential for the prediction in various applications. In future work we will investigate the predictability of this data to exploit potential energy savings by controlling electricity and fan-speed more accurately and based on actual load. In particular, for energy optimal control of this subway subsystem the SEAM4US project develops a predictive control architecture. The control architecture proactively performs energy management tasks based on situations taking place in the future.

Acknowledgements

This work was partially funded by the EU-FP7 project "Sustainable Energy mAnageMent 4(for) Underground Systems" (SEAM4US, FP7-ICT, EEB-ICT-2011.6.4). The authors would like to acknowledge the contributions of their partners and colleagues.

References

[1] Seam4us official website. http://seam4us.eu/. Accessed: 2014-05-19.

[2] Ansuini, R., Vaccarini, M., Giretti, A., and Ruffini, S. Models for the real-time control of subway stations (Chambéry, France, Aug. 2013).

[3] (TMB), T. M. D. B., 2014.