Master Thesis in Progress

Automatic Queue Size Measurement from Surveillance Cameras

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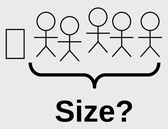
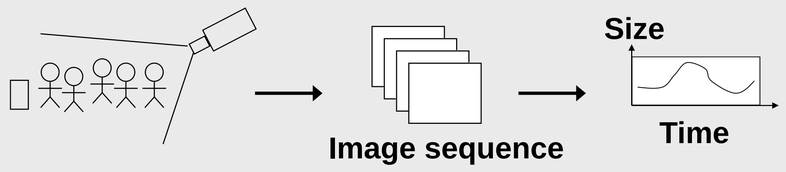
Problem



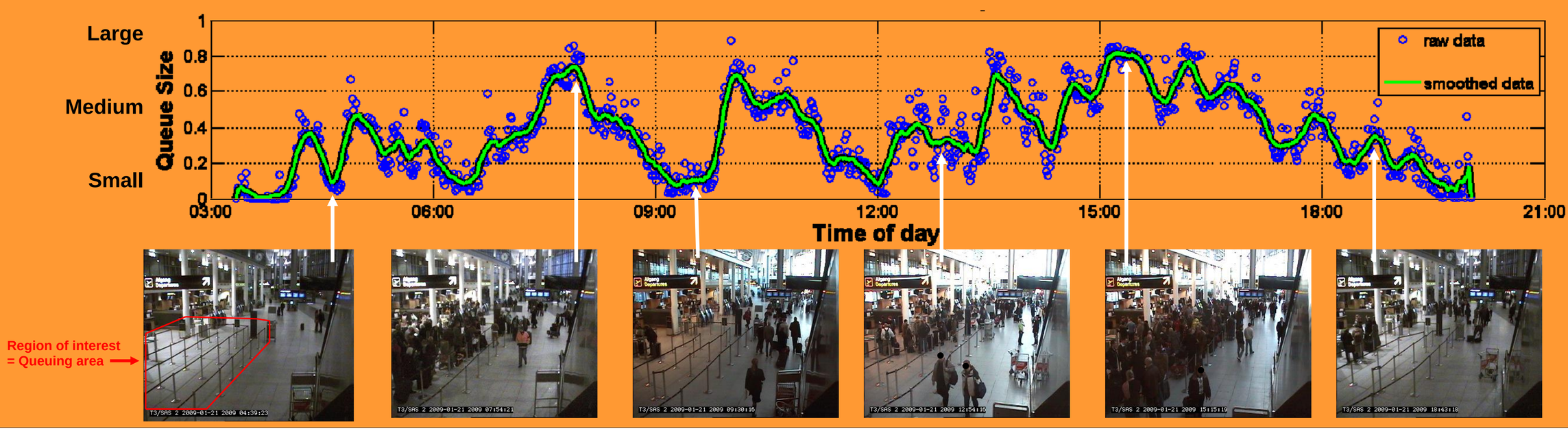
Scandinavian Airlines, SAS, wants to improve staff planning and in that process needs information about queue sizes at the service counters at specific times of the day on various days.

Solution



A cheap and undisturbing solution is to measure the queue sizes from images of the already existing surveillance cameras surveying the queuing areas.

Results



Methods

Images of the queuing area are low resolution (352x288), 24 bit RGB, JPEG compressed. Available seqeunce frequency is 1 frame per minute.

Foreground Segmentation

People are assumed to be foreground. Foreground is found by a kind of **adaptive background subtraction**. The used algorithm is a modified version of Stauffer-Grimson's mixture of Gaussians which can be described as an adaptive Expectation Maximization algorithm.

It's a **pixel wise method**. A number of Gaussian distributions are fitted to observed pixel values, e.g. intensity or some other feature. Distributions that have many matches are deemed to be caused by a background object. If a new observed pixel value doesn't match any of the existing distributions, the distribution with lowest weight will be replaced by a new distribution defined by the newly observed pixel ($\mu=x$, σ^2=predefined value). This is the mechanism whereby new objects gets the chance to become background.

Figure: Each color corresponds to a new distribution. Distributions that have more than say 10 matches are deemed background. Arrows indicate interesting phenomena.

Noise Removal

Result of Foreground Segmentation step will contain noise due to camera noise and compression artifacts.

Intensity

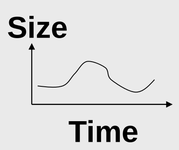
Result of Foreground Segmentation: White is foreground

Morphological opening and closing

Holes filled

Queue Estimation

The queue size is estimated as the foreground pixel count weighed by the distance to the camera and normalized with a full queuing area.

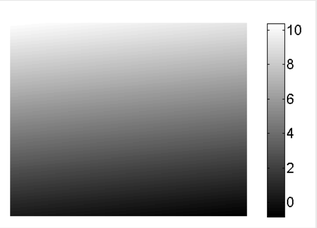


$$Q_t = \frac{\sum_{i \in \mathbf{F_t}} W(p_i)}{A}, \qquad A = \sum_{i \in \mathbf{A}} W(p_i)$$

where $\mathbf{F_t}$ is foreground pixels in frame **t** and **A** is pixels of entire queuing area. W is the weighing function.

Foreground pixels are weighed by the distance to the camera such that one person far away will count equally with one person close.

Foreground pixels are weighed with..



.. approximation of distance to camera (the W function)

Conclusion

This poster is the result of the work done so far on my master thesis. The following problems has been identified:

- Shadows classified as foreground
- Non-human obejcts classified as foreground (e.g. Baggage trolleys)
- Frequently occuring people classified as background

Hopefully these problems can be minimized by introducing more features in the forground segmentation and supervised classification of known non-human objects. Ideas are welcome.

Despite these problems it seems likely that it will be possible to sucessfully measure the queue size within the required accuracy at various queuing areas under different lighting conditions invariant to the appeareance of people.

References

[1] C. Stauffer and W.E.L. Grimson. Adaptive background mixture models for real-time tracking. In *Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition,* volume 2, pages 246-252, 1999.

Acknowledgements

Supervisor: Rasmus Larsen, IMM, DTU, rl@imm.dtu.dk
Industry: Simon Thoustrup, SAS
Tor Justesen, SAS