UROS 2011: Vision-based People Counting System

Introduction

People counting is an important task in safety management. The accurate information about the number of persons at the specific venue would enable the management team for quick reactions to potential overcrowding situations. The current automated solutions for people counting suffer from high computational requirements. Therefore the main scope of this project is a development of an efficient software component for people counting using computer vision approach.

The project lasted for 10 weeks during the summer 2011 and consisted of the following parts:

- week 1-2: a short literature survey, learning the functionality of a specific computer vision library (i.e. OpenCV);
- week 3-4: data collection and annotation
- week 5-6: design and development of a basic people counting system (based on change detection)
- week 7-8: development of the extended version of the system utilising motion information
- week 9-10: evaluation, report writing and poster preparation.

System Overview

The prototype system consists of a camera mounted above a door giving a top down view of the entrance (see Fig. 1) and a PC running the image processing algorithm. The system detects and counts people coming in and out of a room and displays that information on the screen (see Fig. 4).

Design and Implementation

The basic system (see Fig. 2) is based on a simple change detection algorithm, where the current frame is subtracted from the background frame, collected in advance (see Fig. 3). The number of pixels above a specified difference threshold is counted and accumulated over the consecutive frames (see Fig. 5). A person is detected, if the total pixel count exceed a specified threshold value.

The basic system was then extended to not rely on background image (use frame differences instead), to count people coming in and out from different directions and to automatically tune the threshold parameters.

The algorithm was implemented in C++ with additional image processing functionality provided by an open source computer vision library OpenCV.

Figure 1. A web-camera mounted above the door.

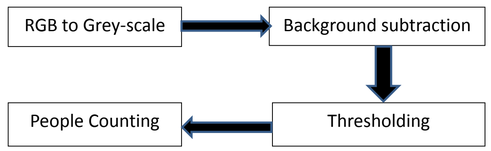

Figure 2. The basic steps of the people counting system.

Evaluation

The efficiency of the system was tested on a video data set containing multiple people coming in and out of the room.

The system can efficiently count people achieving ~94% accuracy with a small percentage (~6%) of false positive counts. In addition, the computational requirements for the system are low and require <10ms per frame (see Fig. 6 for more details).

One major limitation of the current system is inability to count people stopping or turning around within the field of view of the camera. This is a subject for future work.

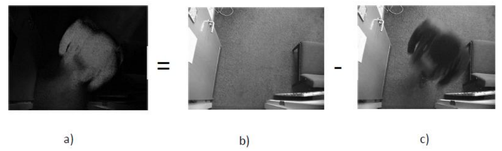

Figure 3. The result of background subtraction: a) result, b) background, c) the current image.

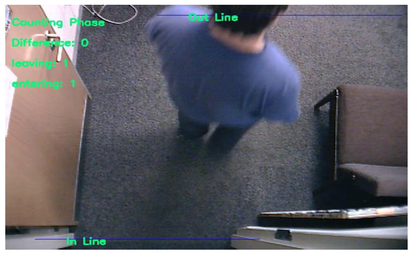

Figure 4. The output screen of the system.

Conclusions

The proposed work has contributed to the research infrastructure of the Centre for Vision and Robotics Research by developing new software components for the existing framework and foundations for a prototype system that could be tested and demonstrated to local authorities managing large crowded events with prospects for future cooperation.

Personally, I have gained experience with programming languages and the state-of-the-art computer vision library. In addition, I could improve my research and writing skills and project management techniques.

Figure 5. Accumulated pixel count for a test sequence with three people.

Image Processing Step	Time [ms]
Converting to grey scale	2.2 +/- 0.05
Background subtraction	0.8 +/- 0.04
Threshold	0.1 +/- 0.02
Path Accumulation	3.8 +/- 0.03
Line Threshold	0.9 +/- 0.02
People Counting	0.7 +/- 0.02

Figure 6. Computation time for different steps of the algorithm.

Author: David Whitehead, *Supervisor:* Dr Grzegorz Cielniak, *Project Date:* 14/06/2011 – 22/08/2011, University of Lincoln