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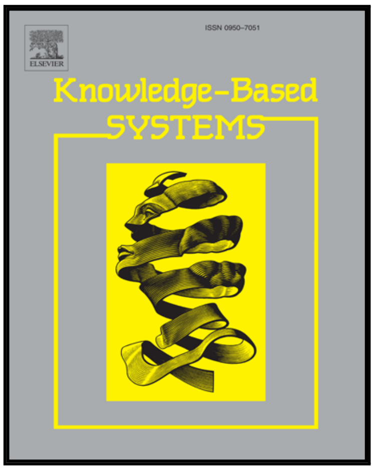

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Passenger Flow Estimation Based on Convolutional Neural Network in Public Transportation System

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Abstract:

Automatic passenger flow estimation is very useful in public transportation system, which can improve the efficiency of public transportation service by optimizing the route plan and traffic scheduling. However, this task usually encounters many challenges in public transportation system, such as low resolution, background clutter, variation of illumination, pose and scale, etc. In this paper we propose a passenger counting system based on the convolutional neural network (CNN) and the spatio-temporal context (STC) model, where the CNN model is used to detect the passengers and the STC model is used to track the moving head of each passenger, respectively. Different from the traditional hand-engineered representation methods, our method uses CNN to automatically learn the related features of passengers. Meanwhile, target pre-location is used by combining the mixture of Gaussian (MoG) model and background subtraction, which can greatly reduce the following detection time. To address the tracking drift problem, inspired by the movement of ants in nature, we attempt to exploit the trajectory information to build a biologically inspired pheromone map and a 3D peak confidence map. Then, the number of passengers can be obtained by counting the regions of interest (ROI). Experimental results on an actual public bus transportation dataset show that this method outperforms some existing methods.

Keywords: Passenger Flow Estimation; Convolutional Neural Network; Biologically Inspired Pheromone Map

1. Introduction

Automatic passenger flow estimation is very useful for traffic management and overcrowding situation detection in public transportation. The accurate passenger flow information can improve the efficiency of public transportation service by optimizing the route plan and traffic scheduling. Meanwhile, it can also prevent severe traffic accidents caused by overloading. Traditionally, automatic passenger counting can be done by contact-type counters, optical sensors, and vision-based systems. Contact-type counters can be applied in many public places with entrances, such as subways and bus stations. However, it can cause congestion when the passenger flow is high because it counts passengers in sequence one by one. Optical sensors, such as radiation beam systems, do not block the doorways, but suffer from the undercounting problem. In recent years, automatic method of counting the passing passengers based on digital image processing has attracted more attention, which can reduce the cost and require no user intervention.

In the past few decades, several methods related to people counting have been proposed. Generally speaking, these methods can be divided into three approaches. The first approach is trajectory clustering based counting. This kind of methods count passengers based on the following hypothesis. Those trajectories belonging to the same human body are more similar than trajectories belonging to different individuals. In [1], the trajectories of visual features were clustered, and the number of passengers was estimated by the number of these clusters. Based on dirichlet process mixture models (DPMMs), Topkaya et al. [2] employed a clustering scheme to estimate the number of passengers. This method fused a set of spatial, color and temporal information features for each detection. However, the performance of these methods will degrade greatly in illumination variation and low resolution transportation scene since this situation usually reduces the stability of the algorithms. The second one is regression based counting. The number of passengers in this type of methods is estimated by learning the regression function between features extracted from the input images and the people counted in a scene. Many regression functions, such as Bayesian regression [3], neural networks [4,5] and SVR regression[6,7], were used to