

CLASSIFICATION OF ABNORMAL CROWD BEHAVIOR USING IMAGE  
PROCESSING AND STATE MACHINES

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An appreciation to all who made this possible  
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## ABSTRACT

The study of crowd behavior in public areas or during public events such as subway station, airport and shopping mall had been started two decades ago. In this thesis, an automated video surveillance to detect abnormal activities in a crowd using the concept of state machine is proposed. This method is divided into three stages which are pre-processing, feature extraction and behaviour classification. In pre-processing, frame differencing is used for segmentation while optical flow is performed to estimate the crowd motion. Extracted features consist of global and local features. Global features will consider the features on the whole frame whereas local features only consider the features on each detected object. Based on extracted features, abnormal crowd behaviour can be classified using state machines. The proposed state machine contains four states which will evaluate different features in different states respectively. The frames that are able to reach the final state of the behaviour in its state machine will be classified as the behaviour. The behaviours that can be detected are walking, running, crowd formation, crowd splitting and panic crowd. The method is validated using UMN data set and PETS 2009 data set. The result of the classification has achieved an accuracy of 96.3%.

## ABSTRAK

Kajian tentang kelakuan orang ramai di kawasan awam atau dalam acara awam seperti stesen kereta api, lapangan terbang dan pusat membeli-belah telah dikaji sejak dua dekad yang lalu. Dalam tesis ini, sistem pengawasan video automatik yang boleh mengesan aktiviti orang ramai yang tidak normal dengan menggunakan konsep mesin keadaan telah dicadangkan. Kaedah ini dibahagikan kepada tiga peringkat iaitu pra-pemprosesan, pengekstrakan ciri-ciri dan pengelasan kelakuan. Dalam pra-pemprosesan, penolakan gambar digunakan untuk segmentasi manakala aliran optik digunakan untuk menganggar gerakan orang ramai. Pengekstrakan ciri-ciri meliputi ciri-ciri global and ciri-ciri tempatan. Ciri-ciri global merupakan ciri-ciri yang diambil daripada seluruh gambar manakala ciri-ciri tempatan merupakan ciri-ciri yang diekstrak daripada objek-objek yang dikesan. Berdasarkan ciri-ciri yang diekstrak, kelakuan orang ramai yang tidak normal boleh dikelaskan dengan menggunakan mesin keadaan. Mesin keadaan yang dicadangkan mengandungi empat keadaan yang akan menilai ciri-ciri yang berbeza dalam keadaan masing-masing. Gambar yang dapat mencapai keadaan yang terakhir bagi mesin keadaan kelakuan akan dikelaskan dalam kelakuan tersebut. Kelakuan yang dapat dikelas dalam sistem ini ialah berjalan, berlari, orang ramai berkumpul, orang ramai berpecah dan orang ramai panik. Kaedah ini telah disahkan dengan menggunakan set data UMN dan set data PETS 2009. Ketepatan hasil pengelasan telah mencapai 96.3%.