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ORIGINAL PAPER

Evaluation of deep learning model for human activity recognition

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Abstract
Recognizing a person's physical activity with certainty makes an important aspect of intelligent computing. Modern smart devices are equipped with powerful sensors that are suitable for sensor-based human activity recognition (AR) task. Traditional approaches to human activity recognition has made significant progress but most of those methods rely upon manual feature extraction. The design and selection of relevant features is the most challenging task in sensor-based human AR problem. Using manually extracted features for this task hinders the generalization of performance and these handcrafted features are also incapable of handling similar and complex activities with certainty. In this paper, we propose a deep learning based method for human activity recognition problem. The method uses convolutional neural networks to automatically extract features from raw sensor data and classify six basic human activities. Furthermore, transfer learning is used to reduce the computational cost involved in training the model from scratch for a new user. The model uses the labelled information from supervised learning, to mutually enhance the feature extraction and classification. Experiments carried on benchmark dataset verified the strong advantage of proposed method over the traditional human AR algorithms such as Random Forest (RF) and multiclass Support Vector Machine (SVM).

Keywords Deep learning · Sensors · Activity recognition · Classification · Convolutional neural network

1 Introduction

Recent years have witnessed a rapid increase in the use of smart portable devices. These devices are becoming more and more sophisticated. Current generation smart phones, fitness trackers, and music players now integrates many varied and powerful sensors (Yuan et al. 2018). These sensors include gyroscope, GPS sensors, accelerometer, direction sensors, temperature sensors etc. The availability of different sensors in these communication devices creates new opportunities for data-mining applications (Kwapisz et al. 2011; Brezmes et al. 2009; Wang and Chen 2017; Angelov et al. 2010). The continuous data extracted from these sensors opens up new areas of intelligent computing (fitness trackers, security, health monitors etc.) (Chennuru et al. 2010; Wu et al. 2011, 2013). One such area is human activity recognition (AR). AR is a classification problem where continuous stream of data from sensors is generated and from this continuous stream only a portion of the data that varies with different activities is of significance. To detect and classify the patterns from this (multi-variate) stream of data is a challenging task (Rokni and Ghasemzadeh 2017; Angelov and Zhou 2008). Mostly used technique in AR is to divide this continuous data stream into overlapping segments or windows. A smaller segment size may not capture all the features of motion states, and a larger segment can incorporate noise due to involvement of multiple states (Reddy et al. 2010). Typically, a segment of one second is often utilized for activity classification, which has been validated by prior work (Peterek et al. 2014). Each window is processed separately and is transformed into feature vectors. Performance of the methods used in recognizing a person's activities depends upon the extracted features and most of the approaches rely upon hand-crafted statistical features like mean, variance, entropy or correlation coefficients (Figo et al. 2010; Bao and Intille 2004). Feature extraction from other domains; time-domain features (e.g., Zero-crossings of acceleration), frequency-domain features (e.g., FFT DC component of acceleration) (Krause et al. 2003) and discrete-domain features (e.g., Dynamic Time

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