

Action Recognition in Physical Rehabilitation - A review

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Abstract

Recognizing actions from film clips or images is a difficult procedure due to difficulties such as crowded backgrounds, occlusions, differences in scale, viewpoint, colour, and look. Various technologies, such as surveillance cameras, human - machine interface, and robotics for human activity description, requires a simultaneous action recognition system. A standard colour camera can identify a moving silhouette in the foreground, but precise assessment of human movements is difficult due to lack of complete three dimensional knowledge of the scene(1). Cameras like RGB-D can combine a depth map based on a colour image and the reflection of an infra red sensor light; they can help in solving the problem. The main aim in rehabilitation is correctness of a movement may be certified without being exceedingly accurate. The precise of skeleton estimation wasalso tested in order to better comprehend the potential clinical applications. The motion detection is a promising area for advancement in fields such as physiotherapy(2).

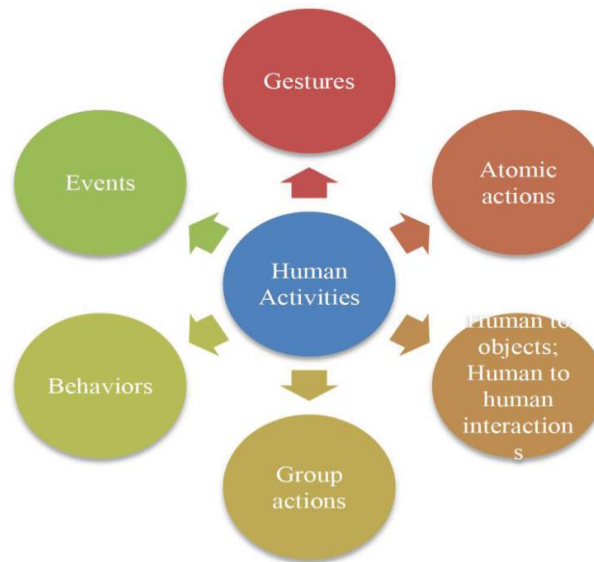
Keywords: Motion detection, rehabilitation, human- computerinteraction, physiotherapy, action recognition .

INTRODUCTION

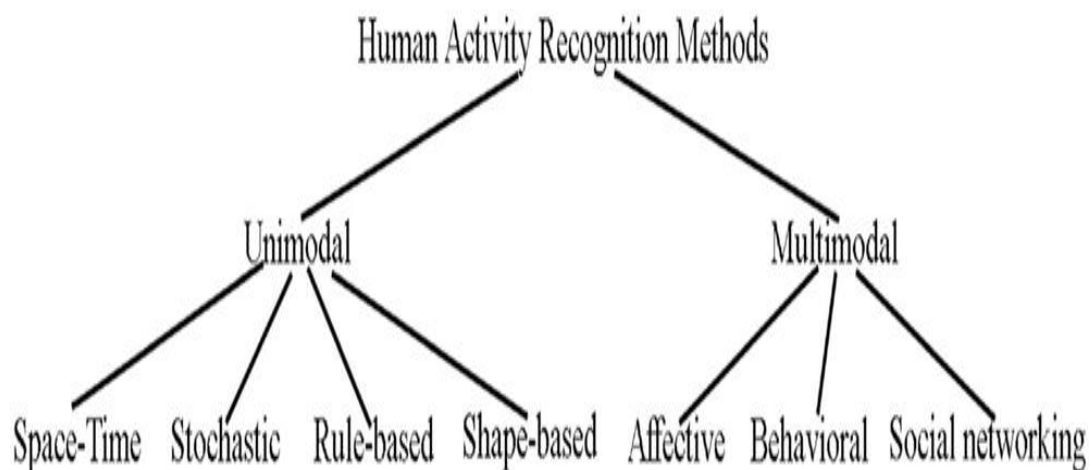
Action recognition aims to assess activities in videos or photos. Human activities divided into 1. Autonomic actions- Autonomic actions are a person's movements that describe a specific motion that may be part of a larger activity; 2. Interaction between humans and objects- interaction between individual and object is the process in which two or more people or things are involved; 3. Collective actions- Collective actions are activities carried out by group or individual; 4. Events; 5. Gestures- regarded as primitive movements of a person's bodily parts which may correlate to a certain activity carried out bya individual; 6. Behaviours- Human Behaviours are physical actions that are linked to an individual's emotions, personality, and psychological condition. When attempting to recognise human actions,in order for the system to identify the activity effectively, one must first comprehend a person's physical characteristics. The way human do an activity is influenced by their habits or any underlying cause, which makes determining the underlying activity challenging(1).

To solve these issues, need to complete a mission that consists of three parts: 1. Subtraction of the background- in which device attempts to discern the difference between components of the image which remain constant with the passage of time (surrounding) and shifting or removal of various components (forepart). 2. Human tracking – involves use of digital to detect body motion over long distance. 3. Object detection and human action- in which system can detect individual's action in a picture(1).

The purpose of action recognition is to evaluate actions caught on film or in photographs. This fact motivates human activity identification systems, and their purpose is to accurately classify data input in with its underlying action category. (1). Classified as follows:



According to the type of sensor data used, human activity recognition systems are divided into 2 categories: Unimodal and multimodal activity detection approaches. Then, depending on how they model human actions, each of these two groups is further broken down into subcategories as:



By using statistical models to represent human operations, stochastic approaches recognise activities. Rule-based techniques describe human behaviours using a set of rules. By modelling the movements of human body components, structure based techniques effectively illustrate greater reasoning tasks. Multimodal approaches are grouped into 3 groups based on how they mix features from several sources: affective, behavioural, and social networking strategies are among the options. Affective approaches based on emotional communications and a person's affective condition. Non-linguistic multimodal indicators such as actions, facial gestures, and acoustic indicators, as well as behavioural features, are studies in treatment approaches (1). For applications such a quantitative study of human mobility is required for computerized rehabilitation and/or analysis of stroke, spinal injury (Si), Parkinson's (PD), or people with other severe disabilities (3). Human action recognition has become a hot study topic in recent years, owing to its importance in video comprehension. In general, human action can be detected via a variety of modalities, including appearance, depth, optical fluxes, and body skeletons(4). It offers a diverse variety of applications, and as a result, it is acquiring traction in the computer vision field.

People's actions can be represented using a variety of data modalities, including Colours, anatomy, distance, thermal, spatial information, activity sequence, sound, speed, and Wi-Fi signal. Depending on the required situations, such methods encapsulate several sources of important but separate data and provide different advantages.(5). Also to investigate how pre-processing affects end-to-end trainability and real-time capabilities in deep learning techniques to video representation(6). The design of

an ideal assistive system must address two significant difficulties in order to help patients improve their experience during home based physical therapy by providing them with advice and feedback(7-18).

The benefit of wearable-based systems would be that action recognition could be customised because the information obtained originates from a single person. It is beneficial in therapeutic settings. Furthermore, information aspects are more varied; effectively describing human bodily circumstances, and hence may be more easily linked to activities. Wearable-based devices also have the advantage of being able to personalize task detectors since the information obtained originates from a particular user. It is especially important in clinical settings. Furthermore, information aspects are much more varied, directly describing human bodily circumstances, and hence may be more easily linked to actions. One or more wearable gadgets are placed on various body parts based on the system setting and the actions to be monitored hand, wrist, ankle, thigh, and elbow. With 98 percent accuracy, a waist-mounted sensor can detect passive human actions. Placing devices on the chest or wrist hinders the user's natural movement, making such technologies even less relevant and useful for aged care applications. Use of kinematic input from Smartphone to relieve consumers of the need of carrying a large data capture module. The recognition accuracy is up to 91 percent.

The following are some of the drawbacks of activity detection using wearable: (1) It may be challenging to acquire the true data since physical actions must be overseen and compared with the information recorded; (2) Analysis may be complex and expensive for various users, necessitating a wide range of gadgets; (19-25) A range of sensing devices available as well as the idea that they must be worn or handled by the individual may cause pain(8).

The use of motion sensors to monitor patient mobility was shown to be suitable for use in a clinical setting. The HAR (human activity recognition) model, which comprises of 2 motion sensors made to wear on the chest and thigh to categorise lying, sitting, standing, and dynamic activities, shown to be suitable for use in a healthcare setting. Hospitalised patients were used to test the model, which was matched to patient self-report. To increase performance, advised that the categorization limits be tailored to each patient. Using triaxial motion sensors placed on the chest and thigh, a rule-based HAR system was used to track position changes in 30 immobilized patients in early neurorehabilitation. The chest-worn motion sensor performed significantly better than the thigh sensor, detecting all of the patients' posture changes, as well as a handful that were not reported in the normal written treatment documentation. The method was viable for tracking immobile patients' posture changes and assessing their overall health(26-30).

Thermal sensors cannot identify dynamic human behaviours like movement in a specific direction, in a single picture, unlike static activities. As an alternative, must examine multiple frames before reaching a decision. As a human approaches the thermal sensor, their distance from the lens system reduces, leading to a large documented item within the frame. The number of active components increases and decreases as a person moves forward as well as backward in relation to the centre frame. Cross-correlation in signal processing is a series of connected series like a function of their motion relative to each other. A principle that uses cross-correlation to identify signal migration may be expanded to identify object displacement when images are provided. Based on this principle, we use the cross-correlation of a centre frame with each other to identify the location of the maximum intensity pixel whenever a human stands in the centre (the centre is present in front of the thermal sensor). The cross-correlation of every incoming frame with respect to the centre determines the displacement of the highest peak camera sensor from the centre. Position of a peak intensity pixel in each incoming frame can be compared to the previous frame(31).

Summary and future perspective

The study described the applicability of machine learning to assessing human motion quality. Machine learning improvements and the availability in cost effective, dependable sensors that detect movements have sparked a surge in interest in automated rehabilitation exercise evaluation. According to studies, there is a high degree of reliability in the level of detail of the participant's activity. Furthermore, it benefits both the client and the medical system. Findings reveal a wide range of outcomes for various action kinds. Raw 3D joint positions appear to be less useful than angle characteristics.

Techniques were categorised into two major groups (unimodal and multimodal) due to the way in which individual activities are evaluated. Unimodal gave classification of methods, designed to evaluate the motions, automatic acts, and more difficult task (by dividing it into easy movements). There are several layers of feature modality representation, each with its own set of constraints and advantages. Future work could include the creation of additional models to recognise a broader range of exercises. The skeletal tracking must be offloaded to an integrated on-board SoC in the camera, or a new, robust skeleton extraction with low processing load must be investigated for embedded systems.

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