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SURVEY ARTICLE

VIDEO MINING AND ANOMALY DETECTION – SURVEY

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Abstract-Data mining is a process of extracting previously unknown knowledge and detecting the interesting pattern from a massive set of data. The amount of multimedia data available to users has increased exponentially. Video is an example of multimedia data. It contains several kinds of data such as text, image, meta-data, visual and audio. It is widely used in many applications like security and surveillance, entertainment, medicine, education programs and sports. In many surveillance mission's huge amounts of data need to be gathered, evaluated and analyzed in order to make the right decision. Interesting events or threats are often hidden within these large amounts of data. The discovery of interesting events is one of the core problem areas of the data-mining research community. Compared to the mining of other types of data, video data mining is still in its infancy. There are many challenging research problems existing with video mining. Beginning with an overview of the video data mining literature, this paper concludes with the applications of video mining.

Keywords-Video processing; Video information retrieval; Video mining; Video association mining

I. INTRODUCTION

The advancement in multimedia acquisition and storage technology has led to a tremendous growth in multimedia databases. Multimedia mining deals with the extraction of implicit knowledge stored in the multimedia data. The management of multimedia data is one of the crucial tasks in the data mining owing to the non-structured nature of the multimedia data. The main challenge is to handle the multimedia data with a complex structure such as images, multimedia text, video and audio data. Nowadays people have accessibility to a tremendous amount of video both on television and internet. So, there is a great potential for video-based applications in many areas including security and surveillance, personal entertainment, medicine, sports, news video, educational programs and movies and so on. Video data contains several kinds of data such as video, audio and text. The video consists of a sequence of images with some temporal information.

The video content may be classified into three categories, namely (i) Low-level feature information that includes features such as color, texture, shape and so on, (ii) Syntactic information that describes the contents of video, including salient objects, their spatial-temporal position and spatial temporal relations between them, and (iii) semantic information, which describes what is happening in the video along with what is perceived by the users. The semantic information used to identify the video events has two important aspects. They are: (a) A spatial aspect presented by a video frame, such as the location, characters and objects displayed in the video frame. (b) A temporal aspect presented by a sequence of video frames in time such as the character's actions and the object's movements presented in a sequence.

Video data sets are large enough and are widespread. There are tools for managing and searching within such collections, but the need for tools to extract the hidden and useful knowledge embedded within the video data is becoming critical for many decision-making applications.

II. VIDEO PROCESSING

The video databases are widespread and hence the acquisition and storage of the video data is an easy task but the retrieval of information from the video data is a challenging task. The most important task is to transform the unstructured data into structured data for the processing of the video data. Before processing the video frames the elimination of the noise and illumination changes should be extracted.

The most fundamental task in video processing is to partition the long video sequences into a number of shots and then find a key frame of each shot for further video information retrieval tasks. The segmentation of the video track into smaller units enables the subsequent processing operations on video shots, such as video indexing, semantic representation or tracking of the selected video information and identifying the frames where a transition takes place from one shot to another. From the segmented video and key frames the low level features can be extracted. The data should be manipulated properly for the information retrieval to be efficient.

Hu et al. presented several strategies in visual content-based video indexing and retrieval to focusing on the video structure analysis, including shot boundary detection, key frame extraction and scene segmentation, extraction of features and video data mining. Zhu et al. described a hierarchical video database management framework using video semantic units to construct database indices. They presented a hierarchical video database model that captures the structures and semantics of video contents in databases. It provides a framework for automatic mapping from the high-level concepts to the low-level representative features.

A. Video Data Mining

Video mining can be defined as the unsupervised discovery of patterns in an audio-visual content. The temporal (motion) and spatial (color, texture, shapes and text regions) features of the video can be used for the task mining.
Oh and Bandi proposed a framework for real time video data mining for the raw videos which is shown in Fig. 1. In the first stage the grouping of input frames takes place to a set of basic units. In the second stage it extracts some of the features from each segment. In the third stage, the decomposed segments are clustered into similar groups. The next two are the actual mining of the raw video sequences and the video data compression for the storage of these raw videos. The knowledge and patterns can discover and detect the object identification, modeling and detection of normal and abnormal events, video summarization, classification and retrieval.

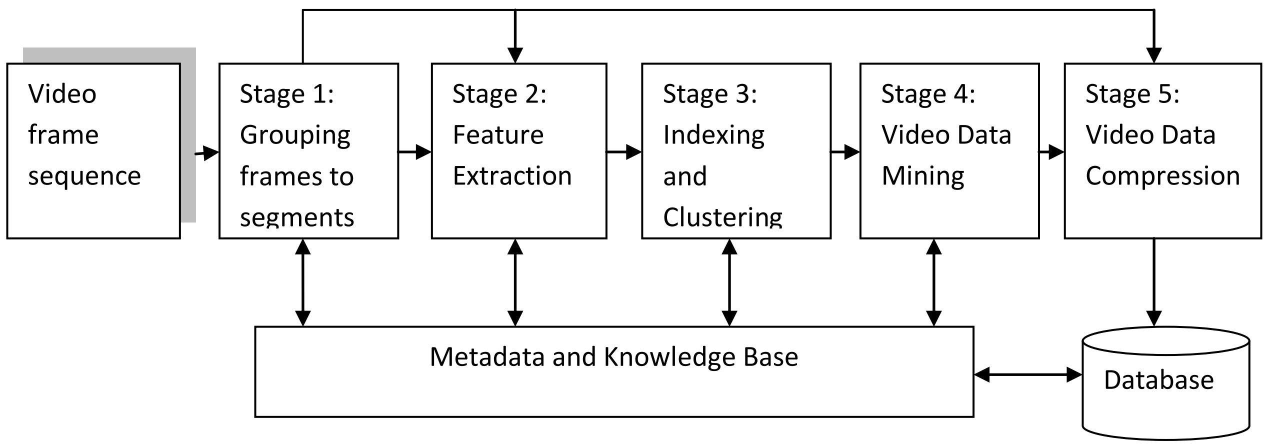

Fig 1. General framework for video data mining

Oh and Bandi and Su et al. proposed a multilevel hierarchical clustering approach to group segments with similar categories at the top level and similar motions at the bottom level using K-Means algorithm and cluster validity method.

B. *Video Data Mining Approaches*

There are many video mining approaches and they are roughly classified into five categories. They are: Video pattern mining, Video clustering and classification, Video association mining, Video content structure mining and Video motion mining.

1) Video structure mining

The main objective of the video structure mining is the identification of the content structure and patterns to carry out the fast random access of the video database. Video structure mining is defined as the process of discovering the fundamental logic structure from the preprocessed video program adopting data-mining method such as classification, clustering and association rule. It is essential to analyze video content semantically and fuse multi-modality information to bridge the gap between human semantic concepts and computer low-level features from both the video sequences and audio streams. Video structure mining is executed in the following steps: (1) video shot detection, (2) scene detection, (3) scene clustering, and (4) event mining.

The current researches on it focus on mining object semantic information and event detection.

2) Video clustering and classification

Video clustering and classification are used to cluster and classify video units into different categories. Therefore clustering is a significant unsupervised learning technique for the discovery of certain knowledge from a dataset. Clustering video sequences in order to infer and extract activities from a single video stream is an extremely important problem and so it has a significant potential in video indexing, surveillance, activity discovery and event recognition. In the video surveillance systems, it is to find the patterns and groups of moving objects that the clustering analysis is used. Clustering algorithms are categorized into partitioning methods, hierarchical methods, density-based methods, grid based methods and model-based methods.

Video classification aims at grouping videos together with similar contents and to disjoin videos with non-similar contents and thus categorizing or assigning class labels to a pattern set under the supervision.

3) Video association mining

Video association mining is the process of discovering associations in a given video. The video knowledge is exploredin a two stages, the first being the video content processing in which the video clip is segmented into certain analysis units extracting their representative features and the second being the video association mining that extracts the knowledge from the feature descriptors. In video association mining, the video processing and the existing data-mining algorithms are seamlessly integrated into mine video knowledge.

4) Video motion mining

Motion is a key feature that essentially characterizes the contents of the video. There have been some approaches to extract camera motion and motion activity in video sequences. While dealing with the problem of object tracking, algorithms are always proposed on the basis of known object region in the frames and so the most challenging problem in the visual information retrieval is the recognition and detection of the objects in the moving videos.

The camera motion having a vital role to play some of the key issues in video motion detections are, the camera placed in static location while the objects are moving (surveillance video, sports video); the camera is moving with moving objects (movie); multiple cameras are recording the same objects. The camera motion itself contains a copious knowledge related to the action of the whole match.

5) Video pattern mining

Video pattern mining detects the special patterns modeled in advance and usually characterized as video events such as dialogue, or presentation events in medical video. The existing work can be divided into two categories such as mining similar motion patterns and mining similar objects.

III. ANOMALY DETECTION

Anomaly detection, also known as deviation or outlier detection is a method to separate a minority of data from a majority of data representing normal events or situations. The strength of anomaly detection is revealed in real-time applications where large amounts of data have to be analyzed on-line. The use of a high-performance anomaly detection system could enable the early proactive detection of potentially threatening events linked to, for instance, terrorism, crime and accidents.

The finding of the objects that deviate from what is considered normal must be done under run-time conditions and not afterwards to enable the organization to initiate adequate responses to the observed behavior. The data needed in order to capture what is to be considered “normal” for the situation at hand is generated bottom-up from the available data.

David Moore(2003) presented a real world system for human motion detection and tracking. This paper presents an operational computer vision system for real-time detection and tracking of human motion. This system captures monocular video of a scene and identifies those moving objects which are characteristically human. This serves as both a proof-of concept and a verification of other existing algorithms for human motion detection. An approach to statistical modeling of motion developed by Y. Song is coupled with a preprocessing stage of image segmentation and point feature tracking. This design allows a system that is robust with respect to occlusion, clutter, and extraneous motion. The results of experiments with the system indicate the ability to minimize both false detections and missed detections.

Jung Hwan Oh et al(2003) presented a technique for mining video data. To extract motions, the system uses an accumulation of quantized pixel differences among all frames in a video segment. As a result, the accumulated motions of segment are represented as a two dimensional matrix. To capture the location of motions occurring in a segment using the same matrix generated for the calculation of the amount is developed. The features (the amount and the location of motions) extracted from the matrix above are used to cluster segmented pieces .This paper presents an algorithm to find whether a segment has normal or abnormal events by clustering and modeling normal events, which occur mostly. In addition to deciding normal or abnormal, the algorithm computes Degree of Abnormality of a segment, which represents to what extent a segment is distant to the existing segments in relation with normal events.

Xingquan Zhu et al(2003) proposed a knowledge-based video indexing and content management framework for domain specific videos (using basketball video as an example). This paper provides a solution to explore video knowledge by mining associations from video data. The explicit definitions and evaluation measures (e.g., temporal support and confidence) for video associations are proposed by integrating the inherent feature of video data. The approach uses video processing techniques to find visual and audio cues (e.g., court field, camera motion activities, and applause) introduces multilevel sequential association mining to explore associations among the audio and visual cues classifies the associations by assigning each of them with a class label and uses their appearances in the video to construct video indices.

Fahad Anwar et al(2010) proposed an efficient periodicity mining technique for the problem of discovering periodicity for sequential patterns. This paper extends a periodic pattern mining approach which has been utilized in association rule mining. However, due to the sequential/temporal nature of sequential patterns, the process of finding the periodicity of a given sequential pattern increases the complexity of the above mentioned association rule mining approach considerably. It provides a comprehensive and flexible problem definition framework for the above mentioned problem. Two main mining techniques are introduced to facilitate the mining process. The Interval Validation Process (IVP) is introduced to neutralize complexities which emerge due to the temporal/sequential nature of sequential patterns, whereas the Process Switching Mechanism (PSM) is devised to increase the efficiency of the mining process by only scanning relevant data-sets from the source database. The approach proposed in this paper is based on a post-mining environment, where the identification of sequential patterns from a database has already taken place.

Ahmed Taha et al(2013) presented a study on behavior analysis in video surveillance and compares the performance of the algorithms on different datasets. The approaches are classified with respect to how they represent the actions and how they recognize actions from a video stream. Although many proposed behavior analysis techniques perform strongly in selected datasets a real-world surveillance video archive is still extremely challenging due to complicated environments, cluttered backgrounds, occlusions, illumination changes, multiple activities, and numerous deformations of an activity. These algorithms are widely used in behavior analysis and reveals important progress.

Christoffer Brax et al(2013) proposed an approach for detecting anomalies in data from visual surveillance sensors. The approach includes creating a structure for representing data building “normal models” by filling the structure with data for the situation at hand, and finally detecting deviations in the data. The approach allows detections based on the incorporation of a priori knowledge about the situation and on data-driven analysis. The advantages of this approach are the low computational requirements, iterative update of normal models and a high explain-ability of found anomalies. The proposed approach is evaluated off-line using real-world data and the results support that the approach could be used to detect anomalies in real-time applications.

IV. APPLICATIONS

The significance of the video data is that they are used in many different areas such as sports, medicine, traffic and education programs. The potential applications of video mining include annotation, search, mining of traffic information, event detection / anomaly detection in a surveillance video, pattern or trend analysis and detection. There are four types of videos in our daily life, namely, (a) produced video, (b) raw video, (c) medical video, and (d) broadcast or prerecorded video.

V. ISSUES

There are five main issues for video mining: video semantic event detection and concept mining, video object motion analysis, representation of video data model, extracting the appropriate video features, and selecting the video data-mining algorithms. The mining of semantic concepts in video data is a core challenge of modern video data management, opening applications like intelligent content filters, surveillance, personal video recommendation, or content-based advertisement. The main challenge is the semantic gap problem which focuses on how to predict semantic features from primitive features. Semantic event detection is still an ordinary problem owing to the large semantic gap and the difficulty of modeling temporal and multimodality characteristics of video streams. Extracting optimal features is an ongoing major challenge. Optimal features should be tailored to the specific application such as motion tracking or event detection, and also utilize multimodal aspects (audio, visual, and text).

VI. CONCLUSION

There has been a tremendous development and application activities in the video data-mining domain. There are many challenging research problems facing video mining such as discovering knowledge from spatial temporal data, inferring high-level semantic concepts from the low-level features extracted from videos and making use of unlabeled data. The detection of unusual and abnormal video events is indispensable for consumer video applications such as sports highlights extraction and commercial message detection as well as surveillance applications. To improve the results of the video data mining, the new features can be constructed by analyzing the heterogeneous data like video text, audio, and videos. There is no meaningful clustering or segmentation method that can be universally applied to all kinds of visual media.

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