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# Real Time Video Segmentation in Cluttered Environment using Graph Cut Approach

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**ABSTRACT:** In this paper we extend the work done in [1] in which graph based approach is described. The algorithm defines a predicate used for segmenting images. In this paper we show the analysis of the defined predicate and vary the threshold K of the predicate and examine the regions generated and determine the best predicate for segmenting images and we further extend this work by implementing segmentation in a video on cluttered environment on 3 different categories of video such as entertainment, sports and nature. For a real life application, video sequence can be of much longer duration. In order to handle the seamless video sequence efficiently, we have proposed one of the ways of handling the memory. Multithreading and Process Concurrency is the underlying principle employed in the model.

**KEYWORDS:** Segmentation, Graph-cut, Graph-weights, Memory model, Multi-threading.

### I. INTRODUCTION

Segmentation is a technique to rationalize and change the depiction of an image into something which is very important and easy to examine. Several segmentation techniques have been developed by the researchers in order to make image easy to evaluate, which is extended in this paper to a video. Video segmentation is the process of partitioning a video sequence into disjoint sets of consecutive frames that are homogeneous according to some defined criteria. Each frame in a shot refers to the image. Video segmentation involves performing image segmentation on its frames. There are numerous methods of segmentation and there is no universal algorithm to segment an image hence we approached to segmentation using graph based approach as discussed in [1]. Graph cut approach is one of the technique to segment an image where the entire image is visualized as a graph where each pixel is termed as a node and the connectivity between pixels is termed as vertices in terms of graph theory, and certain neighboring pixels are connected by undirected edges. Weights on each edge, measure the dissimilarity between pixels. The main characteristic of this approach is, it is capable to group the pixels with lower variation of pixels and ignore the one with higher variation of pixels, which is then segmented by using the cut in the graph from the predicate mentioned in [1] which is used to easily distinguish the segmented regions, where the cut criterion is designed in order to minimize the similarity between pixels that are being split.

There has a been a lot of research on segmenting the images but we find very few instances of introducing segmentation in a video, by introducing it to a video it is very essential to handle the memory for a seamless video as there the is continuous arrival of frames, this problem has been dealt in this paper. This work can have a numerous application where one of the main aim of implementing it is in order to track an object throughout the video where segmentation makes it easier to only concentrate on the interested object.

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## II. LITERATURE SURVEY

There has been a lot of research on segmentation on an image which is a fundamental problem in computer vision. Despite many years of research, general purpose video segmentation is still a very challenging task because segmentation is inherently ill-posed. Among different segmentation schemes, graph theoretical ones have several good features in practical applications. It explicitly organizes the image elements into mathematical structures, and makes the formulation of the problem more flexible and the computation more efficient. In this section, we conduct a systematic survey on segmentation.

[1] The work of Pedro F Felzenszwalb explains about the problem of segmenting an image into regions by defining a predicate for measuring the boundary between regions using graph based representation of an image.

[2] The work of Nida M Zaitoun, Musbah J Aqel explains about the survey on block based image segmentation techniques and come to a conclusion that there is no universal segmentation method for all kinds of images.

[3] Aims at comparative analysis on most popular segmentation techniques such as K means, Watershed, Mean shift, Region Growing on 3 categories of video and determine the best algorithm based on quality metrics.

[4] This paper has proposed a method for automatic detection for segmentation and classification of textured regions in color image and bring the prior information to the graph cut framework.

[5] Bo Peng, Lei Zhang, David Zhang have proposed graph theoretical methods for image segmentation, where the problem is modeled in terms of partitioning a graph into several sub-graphs such that each of them represents a meaningful object of interest in the image.

[6] In this paper, they have proposed a novel image segmentation approach based on the clustering algorithm. This segmentation method could determine the cluster number and centers directly based on the decision graph, which is composed with the density  $\rho$  and distance  $\delta$ .

[7] In this paper, they have developed a grouping algorithm, by treating the grouping problem as a graph partitioning problem, and proposed the normalized cut criteria for segmenting the graph.

## III. PROPOSED WORK

This section discusses about the implementation in 4 sections

### Graph Cut approach.

As discussed earlier this is the extended work of [1] where graph based approach is discussed as follows.

Graph-cut segmentation techniques generally represent the problem in terms of a graph  $G = (V; E)$  where each node  $V_i$  (vertex  $i$ ) belongs to  $V$  (vertices) corresponds to a pixel in the image, and the edges in  $E$  connect certain pairs of neighboring pixels. A weight is associated with each edge based on some property of the pixels that it connects, such as their image intensities.

Let  $G = (V; E)$  be an undirected graph with vertices  $V_i$  (vertex  $i$ ) belongs to  $V$  (vertices) which are the set of elements to be segmented, and edges  $(v_i; v_j)$  belongs to  $E$  corresponding to pairs of neighboring vertices. Each edge  $(v_i; v_j)$  belongs to  $E$  has a corresponding weight  $w(v_i; v_j)$ , which is a non-negative measure of the dissimilarity between neighboring elements  $v_i$  and  $v_j$ . In the case of image segmentation, the elements in  $V$  are pixels and the weight of an edge is some measure of the dissimilarity between the two pixels connected by that edge (e.g., the difference in intensity, color, motion, location or some other local attribute).

A segmentation  $S$  is a partition of  $V$  into components such that each component (or region)  $C$  belongs to  $S$  corresponds to a connected component in a graph  $G_0 = (V; E_0)$ , where  $E_0$  is a subset of  $E$ . In other words, any segmentation is induced by a subset of the edges in  $E$ . This means that edges between two vertices in the same component should have relatively low weights, and edges between vertices in different components should have higher weights

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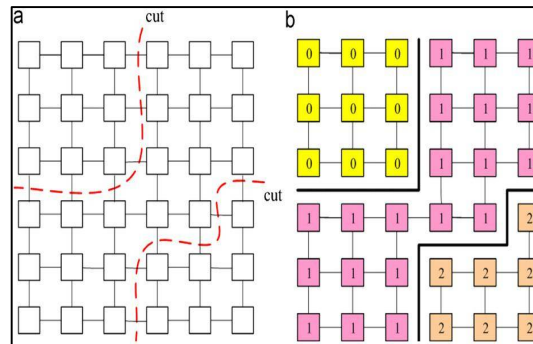


Fig. 1. Is an example of graph cuts and the corresponding vertex labeling (a) Shows a graph whose vertices are image pixels, and maintains the 4-neighborhood system. Graph cuts separate the graph into three subgraphs. A labeling shown in (b) assigns some label {0, 1, 2} to each pixel w.r.t. the graph cuts. Thick lines show labeling discontinuities between neighboring pixels.

## Memory management

There is a short interval of time between the arrival of frames. We must assume that all the calculations are completed before the arrival of the next frame. Hence we require memory management technique to handle video seamlessly with no loss of information. The computational time required for one frame was far exceeding the frame to frame delay required in maintaining the intended frame rate of the input video stream. As a result, a memory model has been implemented in order to overcome the above problem and perform segmentation on a video smoothly.

When a video frame arrives:

- 1 Pool of threads available is divided into graph weight task threads and segmentation threads.
- 2 When a new frame arrives a thread is fetched from the pool and the task of calculating graph weights is assigned to it.
- 3 The processed frame is pushed into a buffer, then the weighted frames are then processed by the segmentation threads and produce a labeled frame.
- 4 The labeled frame is then used for false coloring in order to distinguish different regions.

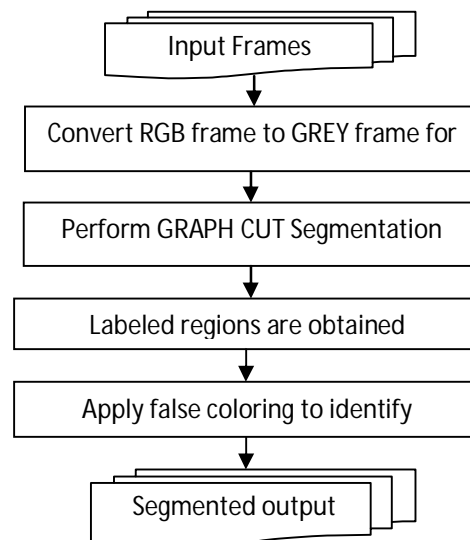


Fig 2 Represents the flow diagram in order to achieve video segmented outputs.

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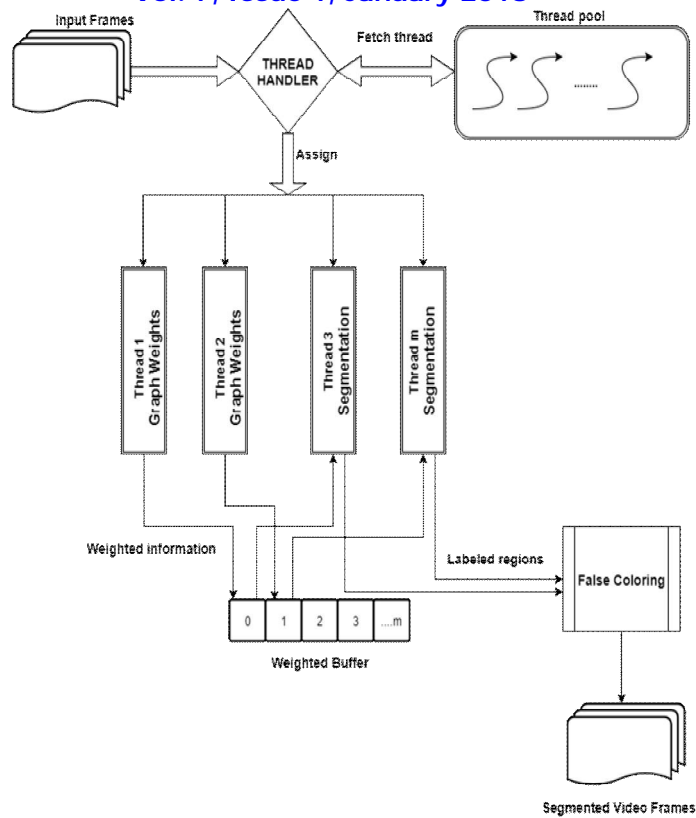


Fig 3 Represents the Memory Model flow that has been implemented for Video.

## Timing Analysis

For the proposed memory management scheme it was necessary to examine its performance on different length of videos with and without the memory model. The analysis has been tabulated for different length of videos by skipping the consecutive frames in a video, as there is no significant loss of information lost in consecutive frames we can afford to skip consecutive frames

Input video time	Without memory model	With memory model
5 min	6.32	3.95
10 min	14.97	9.86
15 min	18.39	12.13
24 min	29.16	18.68

From this table it is evident that with the help of memory model the input video for a seamless video can be handled very efficiently, it is observed that the memory model can give an efficiency of around 60%.

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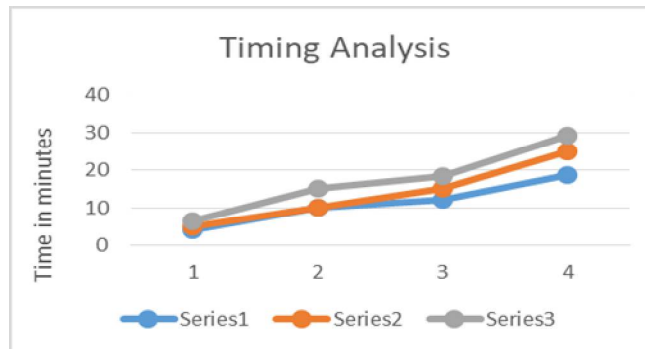


Fig 4 Represents the graph of the tabulation, Series1 curve represents the timing of segmented video with memory model, Series2 curve represents the timing of input video, and Series3 curve represents the timing of segmented video without memory model.

It is clear from the analysis by introducing memory model the time taken has drastically reduced which can be observed in the graph.

## False coloring

False coloring is a final step of processing in order to produce a segmented image where the segmented regions can be easily identified and the entire scene is reconstructed with the help of labeled frame. In this technique we restrict ourselves to certain colors i.e. if the image produces 300 regions we don't need 300 color to represent the regions we can limit the color based on user choice in this case we have set a limit up to 16 where we see through it that no adjacent regions are given the same color, and moreover all the colors selected are contrast to each other so the viewer can easily identify the regions as u can observe these in the results section.

## IV. EXPERIMENTAL RESULTS

The above discussed segmentation method is implemented and analyzed with different values of K and analyzed for different categories of video.

### Category 1: Sports



Fig. 5. Sub image (a) shows an Input Frame of a sports video sequence. The different segmentation outputs obtained on this frame for (b) K = 300, (c) K = 900, (d) K = 1200.

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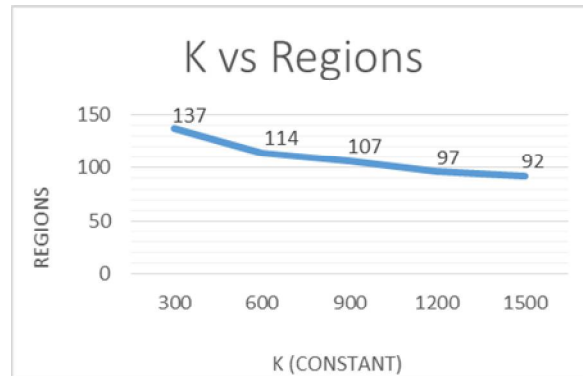


Fig. 6. Shows the analysis of K versus the regions for the sports category frame as K increases the regions decreases

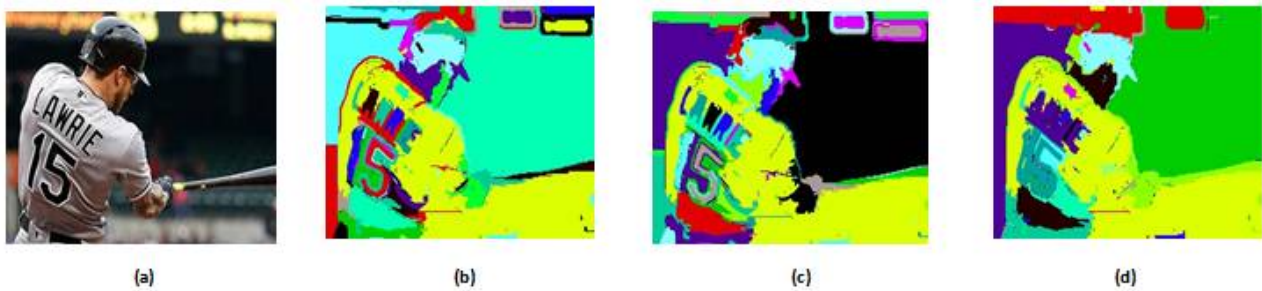


Fig. 7. Sub image (a) shows an Input Frame of a sports video sequence. The different segmentation output obtained on this frame for (b) K = 300 (c) K = 900, (d) K = 1200

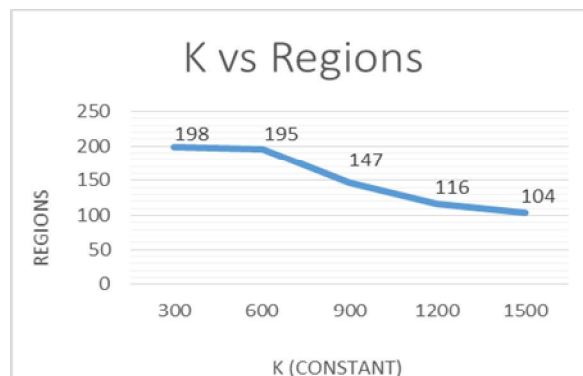


Fig. 8. Shows the analysis of K versus the regions for the 2<sup>nd</sup> sports category frame as K increases the regions decreases

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## Category 2: Nature

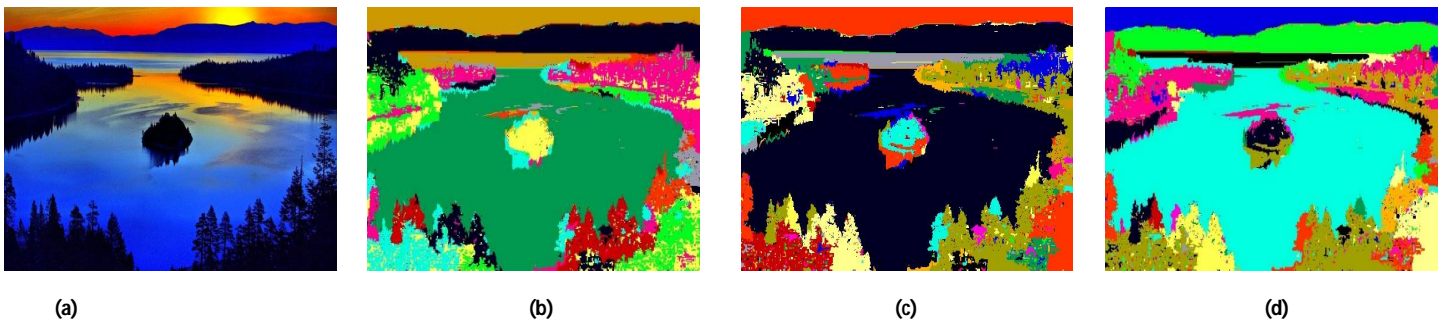


Fig. 9. Sub image (a) shows an Input Frame of a nature video sequence. The different segmentation output obtained on this frame for (b) K = 300 (c) K = 900, (d) K = 1200.

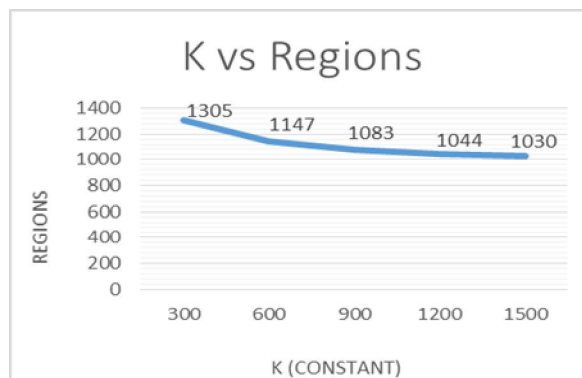


Fig. 10. Shows the analysis of K versus the regions for a nature category frame as K increases the regions decreases

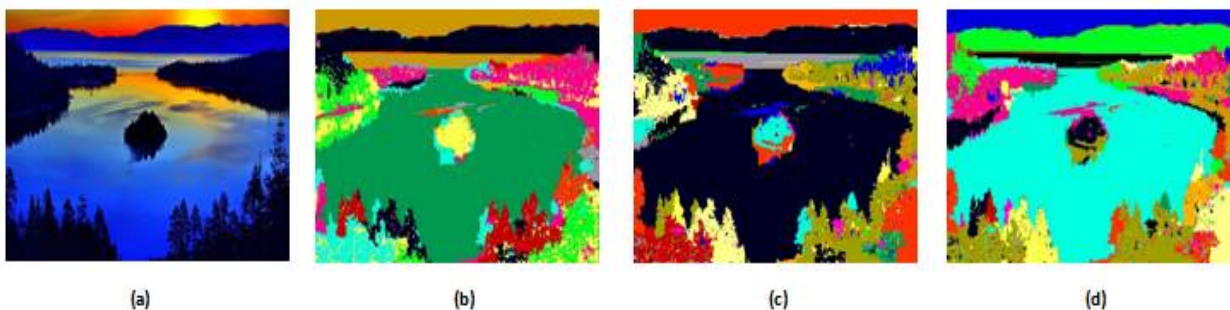


Fig. 9. Sub image (a) shows an Input Frame of a nature video sequence. The different segmentation output obtained on this frame for (b) K = 300 (c) K = 900, (d) K = 1200.

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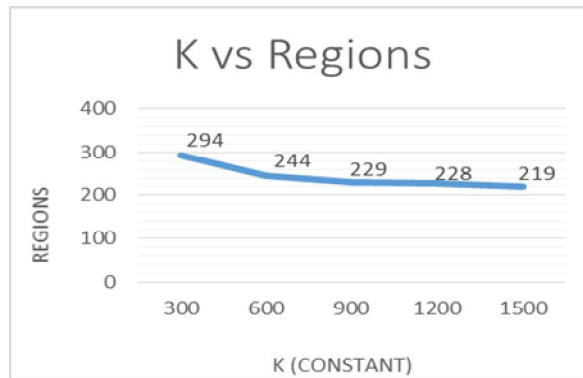


Fig. 12. Shows the analysis of K versus the regions for the 2<sup>nd</sup> nature category frame as K increases the regions decreases

### Category 3: Entertainment

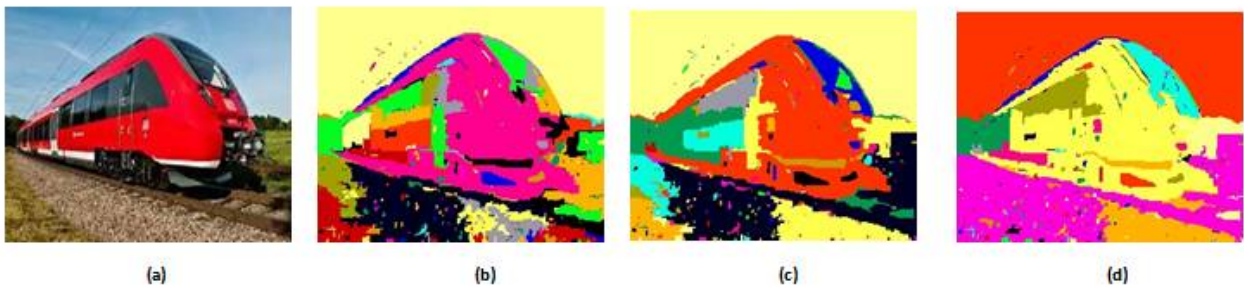


Fig. 13. Sub image (a) shows an Input Frame of an entertainment video sequence. The different segmentation output obtained on this frame for (b) K = 300 (c) K = 900, (d) K = 1200.

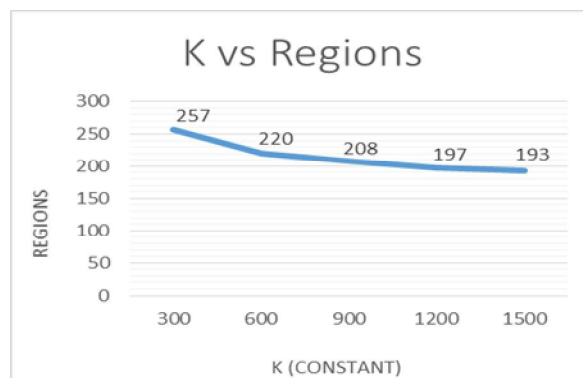


Fig. 14. Shows the analysis of K versus the regions for the entertainment frame as K increases the regions decreases



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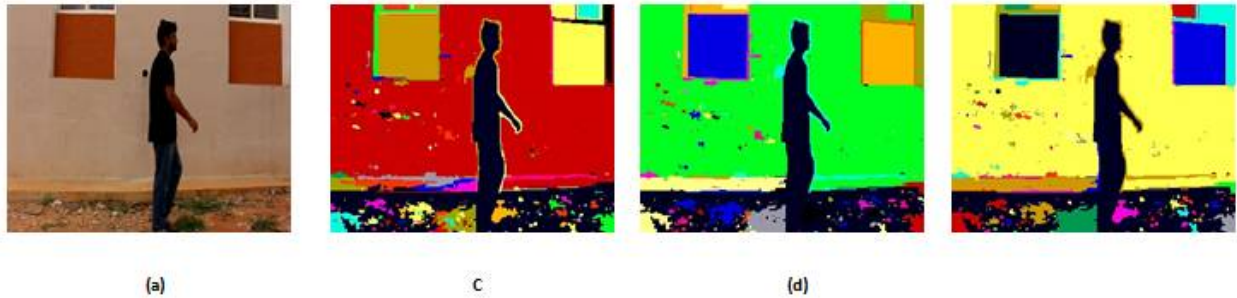


Fig. 15. Sub image (a) shows an Input Frame of an entertainment video sequence. The different segmentation output obtained on this frame for (b) K = 300 (c) K = 900, (d) K = 1200.

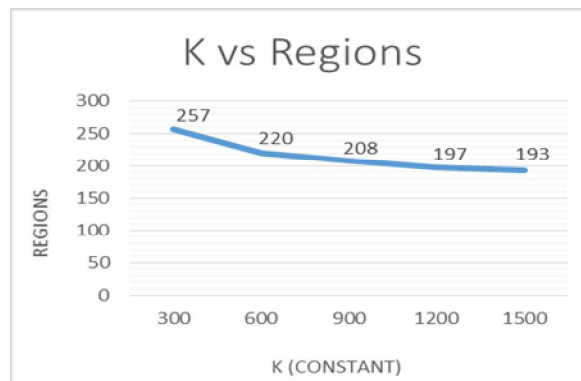


Fig. 16. Shows the analysis of K versus the regions for the 2<sup>nd</sup> entertainment frame as K increases the regions decreases.

### V. CONCLUSIONS

Unlike other reported research work, where segmentation is often used on images, in this paper we have used it on videos keeping in mind of seamless video as input, and processed in real time with the proposed memory management scheme on 3 different categories of videos. From the results obtained from different category of video we can infer that the algorithm can distinguish more regions for a smaller value of K as a result the segmented output is cruder and for larger values of K its smoother.

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