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Abrupt Scene Change Detection

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***Abstract*—**A number of automated shot-change detection methods for indexing a video sequence to facilitate browsing and retrieval have been proposed in recent years. This paper emphasizes on the simulation of video shot boundary detection using one of the methods of the color histogram wherein scaling of the histogram metrics is an added feature. The difference between the histograms of two consecutive frames is evaluated resulting in the metrics. Further scaling of the metrics is performed to avoid ambiguity and to enable the choice of apt threshold for any type of videos which involves minor error due to flashlight, camera motion, etc. Two sample videos are used here with resolution of 352 X 240 pixels using color histogram approach in the uncompressed media. An attempt is made for the retrieval of color video. The simulation is performed for the abrupt change in video which yields 90% recall and precision value.

***Keywords*—**Abrupt change, color histogram, ground-truthing, precision, recall, scaling, threshold.

I. INTRODUCTION

VIDEO is the most effective media for capturing the world around us. Video has been the primary concern of the movie and television industry. Over the years that industry has developed detailed and complete procedures and techniques to index, store, edit, retrieve, sequence and present video material.

Conceptually the video retrieval system should act like a library system for the users. Video materials should be modeled and stored in a similar way for effective retrieval. Shot change detection is the procedure for identifying changes in the scene content of a video sequence so that alternate representation may be derived for the purposes of browsing and retrieval. e.g. key frames may be extracted from a distinct shot to represent it.[1]

The definition of a shot change is difficult to make. Pronounced object or camera motions may change the content of the view frame drastically.

Shot change may occur in a variety of ways: Cuts, where a frame from one shot is followed by a frame from a different shot, or gradual transitions such as cross dissolves, fade-ins, fade-outs and various graphical effects (wipes, pins) which may also be accorded varying semantic significance (e.g. a fade out to black, followed by a fade-in, is often used by film directors or editors to indicate the passage of time or change of location).

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II. VIDEO SEGMENTATION

The success of the segmentation approach depends largely on how well the video materials are divided into segments or shots.

A shot is defined as a part of the video that results from one continuous recording by a single camera. A scene is composed of a number of shots, while a television broadcast consists of a collection of scenes. The gap between two shots is called a shot boundary.

There are mainly four different types of common shot boundaries within shots:

- *A cut*: It is a hard boundary or clear cut which appears by a complete shot over a span of two serial frames. It is mainly used in live transmissions.
- *A fade*: Two different kinds of fades are used: The fade-in and the fade-out. The fade-out emerges when the image fades to a black screen or a dot. The fade-in appears when the image is displayed from a black image. Both effects last a few frames.
- *A dissolve*: It is a synchronous occurrence of a fade-in and a fade-out. The two effects are layered for a fixed period of time e.g. 0.5 seconds (12 frames). It is mainly used in live in-studio transmissions.
- *A wipe*: This is a virtual line going across the screen clearing the old scene and displaying a new scene. It also occurs over more frames. It is commonly used in films such as *Star Wars* and TV shows.

As these effects exist, shot boundary detection is a non-trivial task.

There have been a number of various approaches to handle different shot boundaries.[2]

A. Shot Boundary Detection based on Color Diagrams

The first approach tested at Dublin was a shot detection based on color histograms. They computed frame-to-frame similarities based on colors which appeared within them, albeit of the relative positions of those colors in the frame. After computing the inter-frame similarities, a threshold can be used to indicate shot boundaries.

It needs dynamic threshold to work on other effects than simple shot boundaries.[4]

B. Edge Detection

The next approach is Edge Detection which is based on detecting edges in two neighboring images and comparing these images. It should be possible to detect all kinds of shot boundaries by detecting the appearance of edges in a frame which are far away from the ones in the previous frame. The tested approach in Dublin used over 2 hours and 40 minutes of

video files of different TV broadcasts. They spotted various reasons why their program missed a real cut between scenes:
• blurred images where the edges could not be defined clearly
• images with similar backgrounds or intensity edges to the next-following image
• dark or bright images where the edges are not defined in an accurate manner
• straight cuts from a blank screen to a dark screen
• a cut between different camera perspectives showing the same scene.
They also detected reasons for wrong identification of cuts:
• fast action scenes with fast moving and changing edges
• camera flashes
• close-up moving scenes
• objects moving in front of the camera lens without being present on the image before
• a zoom out or in, camera pan or any camera motion
•computer generated scenes
•interferences in the video from broadcasting or recording
•an object cut from an image

Main problems for missing cuts in all kinds of videos are cuts between dark scenes and the detection of so-called pseudo-cuts during the credits at the end of a film or programme. They also found out that the detection of false shots increases with the quality and size of the example videos. Since many false detection had occurred because of camera panning and/or zooming they implemented a technique to compensate these movements. This solution can counter problems caused by dissolves and fades and other changes using soft colour changes. The advantage – compared to colour based shot detection – is that this technique will not be fooled by colour changing effects like a flash. But on the other side, each frame has to be decoded, so it runs very slowly.[7]

C. *Shot Boundary Detection Using Macroblocks*

Besides, they investigated the *shot boundary detection using macroblocks*. Depending on the types of the macroblock the MPEG pictures have different attributes corresponding to the macroblock. Macroblock types can be divided into forward prediction, backward prediction or no prediction at all. The classification of different blocks happens while encoding the video file based on the motion estimation and efficiency of the encoding. If a frame contains backward predicted blocks and suddenly does not have any, it could mean that the following frame has changed drastically which would point to a cut. This approach, however, becomes difficult to implement when there is a shot change, and the frame in the next shot contains similar blocks as the frame before.

Above are different techniques for segmentation and we are focusing on the method where in histogram of the color image we are scaling in order to get good result. [3] [6]

III. Detection Principle

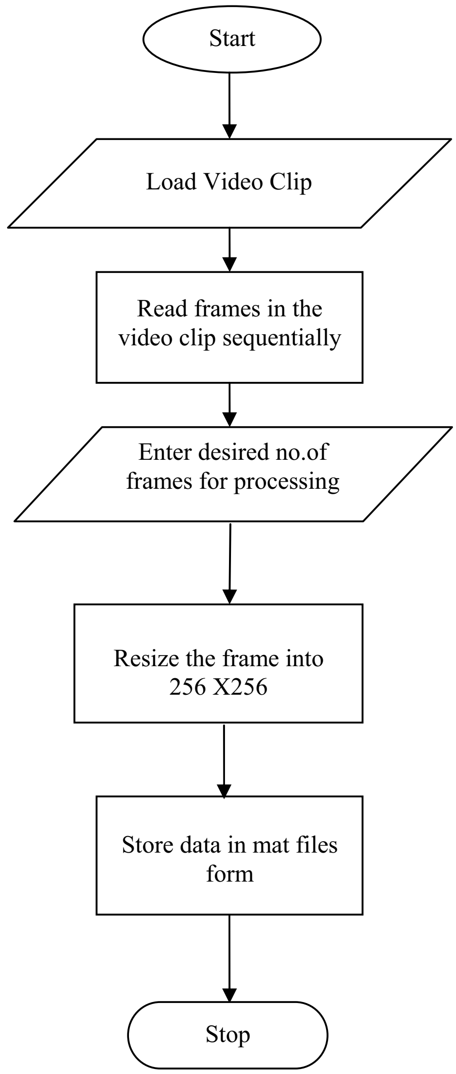

Fig. 1 Flow chart for creating data base

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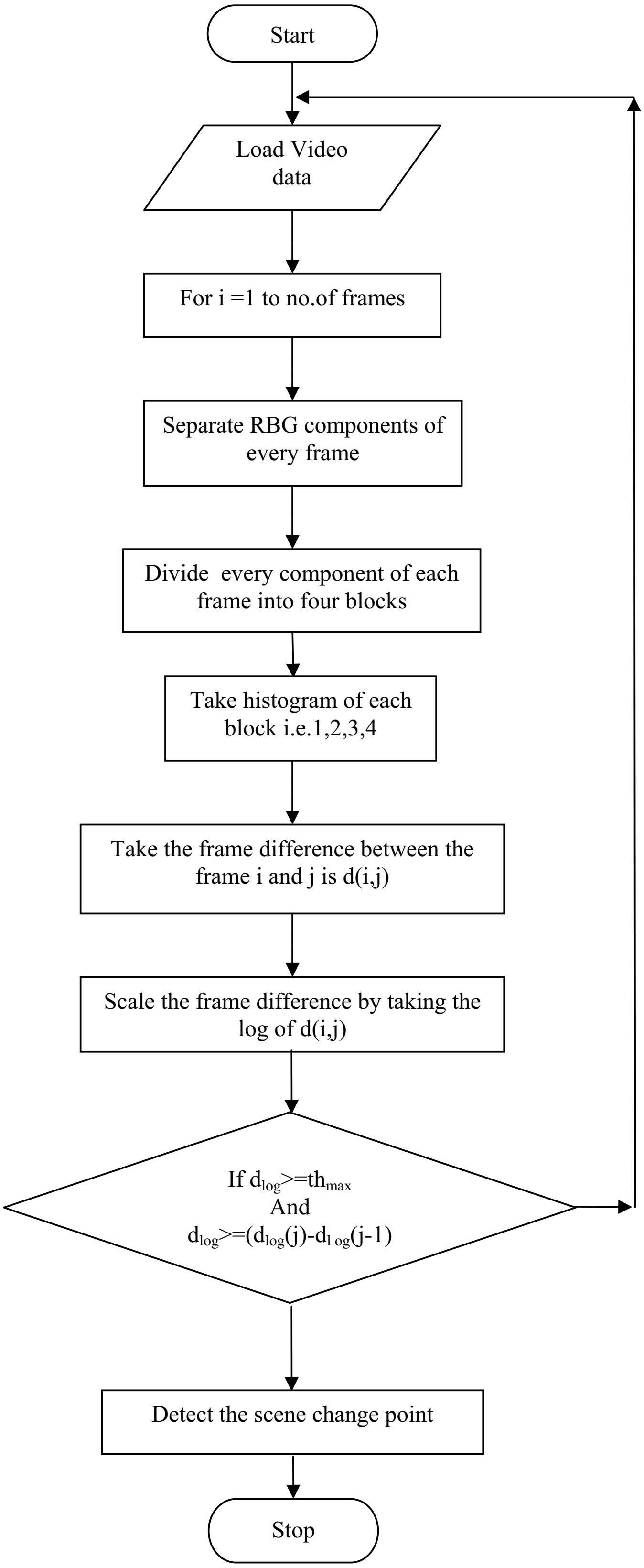

Fig. 2 Flow chart for abrupt change in video transition

IV. Algorithm Evaluation

A. Metrics in Scene Change Detection

To extract robust frame difference from consecutive frames, we used verified x^2 test which shows good performance comparing existing histogram based algorithm and to increase detection effect of color value subdivision work, color histogram comparison using the weight of brightness grade. Also to reduce the loss of spatial information and to solve the problem for two different frames to have similar histogram, we used local histogram comparison.

Color histogram comparison ($d_{r,g,b}(f_i,f_j)$) is calculated by histogram comparison of each color space of adjacent two frame (f_i,f_j) and it is defined as (1).

$$d_{r,g,b}(f_i,f_j)=(|H_i^r(k)-H_j^r(k)|+|H_i^g(k)-H_j^g(k)|+|H_i^b(k)-H_j^b(k)|) \quad (1)$$

$H^r_i(k)$,$H^g_i(k)$,$H^b_i(k)$ represent the number (N) of bean (k) of each color space (r,g,b) in i frame f_i. Using the weight for brightness grade change of each color space from (1), we can redefine it as (2).

$$d_{wrwgwb}=\sum(|H_i^r(k)-H_j^r(k)|\times\alpha+|H_i^g(k)-H_j^g(k)|\times\beta+|H_i^b(k)-H_j^b(k)|\times\gamma) \quad (2)$$

α,β,γ shows the constants to change the brightness grade according to NTSC standard and it is defined as $\alpha = 0.299$, $\beta = 0.587$, $\gamma = 0.114$.

Among static analysis method for emphasizing the difference of two frames, X^2 test comparison ($d_{wx}^2(f_i,f_j)$) is efficient method to detect scene change by comparison change of the histogram and it is defined as (3).

$$d_{wX^2}(f_i,f_j)=\begin{cases}\sum\dfrac{((H_i(k)-H_j(k))^2}{\max((H_i(k),H_j(k))} & if(H_{i,j}\neq 0)\\ 0 & Otherwise\end{cases} \quad (3)$$

The histogram based method may have a problem to detect two different with similar color distribution as same image as it doesn't use the spatial information. This problem can be solved by the method of comparing local histogram distribution as dividing frame area. The value of frame difference through color histogram comparison of each area according to the area division and its accumulation is given by (4)

$$d(f_i,f_j)=\sum_{bl=1}^{m}DP(f_i,f_j,bl)$$
$$DP(f_i,f_j,bl)=\sum_{k=1}^{N-1}|H_i(k,bl)-H_j(k,bl)| \quad (4)$$

$H_i(k,bl)$ is the histogram distribution of k position of the frame (f_i) block(bl) and m is the number of total blocks.

Using the merits of subdivided local histogram comparison applying weight to each color space in above (2), value of difference expansion using statistical method of (3) and use of spatial information of the frame by local histogram as (4), in this paper, The value of difference extraction formula, is given in (5) by combining above formulas, will be used for robustness and reliance of value of difference extraction.

$$d(f_i,f_j)=\sum_{N=1}^{m} d_{\chi^2}(f_i,f_j,bl)$$

$$d_{\chi^2}(f_i,f_j,bl)=\sum_{k=1}^{N-1}\left(\frac{(H_i^r(k)-H_j^r(k))^2}{\max(H_i^r(k),H_j^r(k))}\right)\times\alpha+\left(\frac{(H_i^g(k)-H_j^g(k))^2}{\max(H_i^g(k),H_j^g(k))}\right)\times\beta+\left(\frac{(H_i^b(k)-H_j^b(k))^2}{\max(H_i^b(k),H_j^b(k))}\right)\times\gamma \quad (5)$$

In above formula, $H^r_i(k)$, $H^g_i(k)$, and $H^b_i(k)$ is histogram distribution of each space $b\ g\ r$, , owned by number i frame $i\ f$, N is total number of bean k and m is the total number of the blocks bl

Here, the value of difference was created from (5) by histogram comparison of each block after dividing the frame into same block areas. Created value shows the extraction of robust value of difference which can be applied to both abrupt scene change.[4]

B. *Scaled Frame Difference*

Extracted frame difference from suggested formula (5) has big variation with characteristic information between frames and it is very hard to get consecutive connected information between frames. Especially, it has a problem that the threshold value decision to extract scene change should meet the change of each value of difference actively.

Therefore the way to reduce the variation of value of difference, to recognize the value of difference connected by time easily and to get the information is required. Existing regulation method using total pixel numbers of the frame is used as reducing the value of difference size by certain area but it has a demerit that it can't supply the information on time consecutiveness and correlation of the value of difference.

In this paper, we propose the scaled frame difference method to extract more robust scene change from frame difference as recognizing time consecutiveness and correlation by compressing the frame difference dynamically in certain range of the value. Proposed method is applied to frame difference as modifying log function and multiplying constant used to improve brightness of image in image processing.

$$d_{\log} = c \times \log(1+d^2)$$

$$c=\left(\frac{\max(d_{\log})}{\max(\log(1+d^2))}\right) \quad (6)$$

Where d is the frame difference extracted from (5) and c is the constant calculated from d. Square of frame difference is needed to show the difference value in dynamic range.

Distribution of all frame differences d_{log} has widely spread difference values in a scaled region than d and each difference values are enhanced and concatenated each other more closely. So if we apply the simple shot cut rules, we can detect the shot boundaries only using the frame difference.[5]

V. Experimental Results

A. The formulae mentioned below calculates recall and precision where [1]

$$\mathrm{Re}call = \left(\frac{Correct}{Correct + False}\right)$$

$$\Pr ecision = \left(\frac{Correct}{Correct + Missed}\right)$$

B. The Description of the sequences in the dataset is given in the Table I:

TABLE I
DESCRIPTION OF THE SEQUENCES IN THE DATASET

Sequence	Length(min)	No.of Frames	No.of Cuts
Sleepy Hollow	105	2202	43
Independence day	144	1231	17

The abrupt change in the scene after applying the algorithm is given in the Table II.

TABLE II
RESULT AFTER APPLYING ALGORITHM

Sequence	# of scene change cuts	# of detectedscene change cuts	Precision (%)	Recall (%)
Sleepy Hollow	43	38	90.47	88.37
Independence Day	17	14	87.5	82.35

C. Result for movie sleepy hallow:

For data set 140 to 143

Using Color Histogram difference between the frames:

(For Data set 140 to 143) ie for 3*24 = 72 frames

Abrupt transition of shot is at frame 26

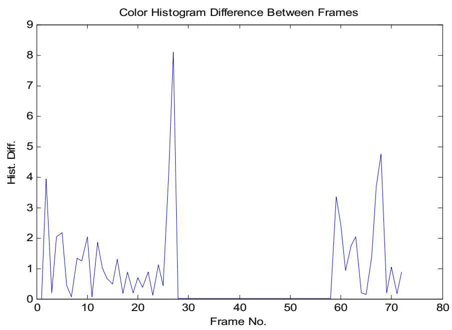

Fig. 3 Result for color histogram difference method for data 140 to 143

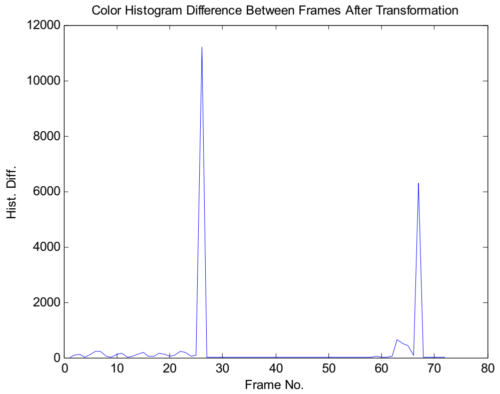

Fig. 4 Result for color histogram difference method after transformation for data 140 to 143

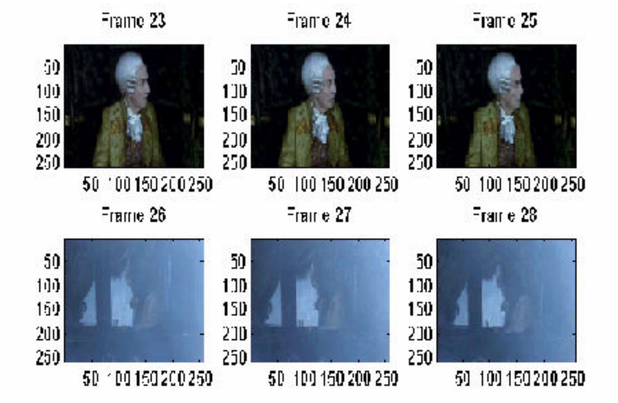

Fig. 5 Result for color histogram difference method after transformation

D. For data set (140 to 143) ie 3*24 = 72 frames from the movie sleepy hallow. Color histogram difference between the frames before transformation.

Abrupt transition of the shot is at frame no 67.

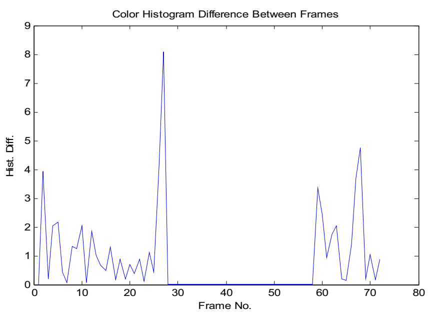

Fig. 6 Result for color histogram difference method for dataset 140 to 143

Color histogram difference between the frames after transformation

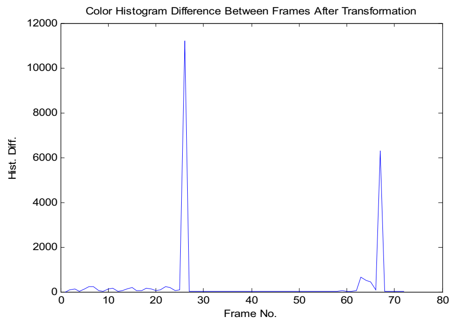

Fig 7 Result for color histogram difference method after transformation for dataset 140 to 143

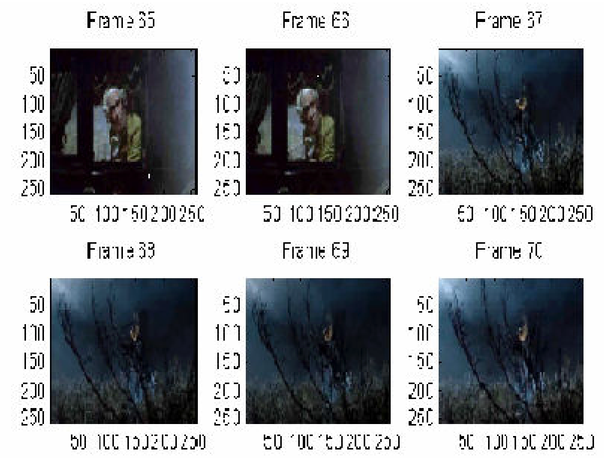

Fig. 8 Result for color histogram difference method after transformation case one

E. For data set 5399 to 5402 i.e.
number of frames = 24*3 = 72 for the movie Independence day
Abrupt Transition of the frame is at 26.
Color histogram differences between the frames are:

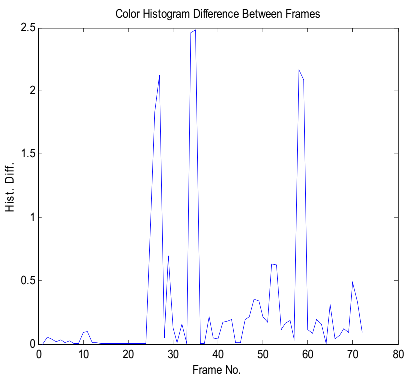

Fig. 9 Result for color histogram difference method for data set 5399 to 5402

Color histogram difference between the frames after transformation:

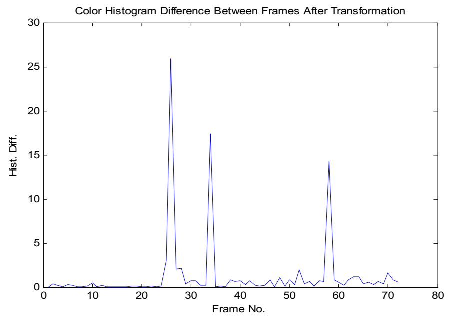

Fig. 10 Result for color histogram difference method after transformation for data set 5399 to 5402

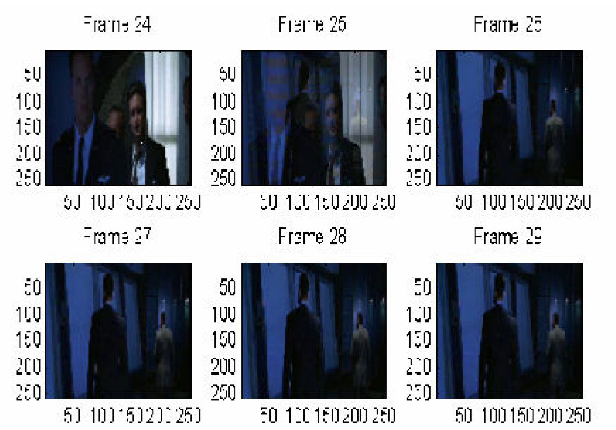

Fig. 11 Result for color histogram difference method after transformation case one

VI. Conclusion and Future Work

Here in this paper we have proposed new segmentation method based on color difference histogram. We have developed a new scene change detection method by scaling the histogram difference between the two frames.

This paper has presented an effective shot boundary detection algorithm for abrupt transition, which focuses on following difficult problems solution: i.e. 1) to provide the scaled frame difference that is dynamically compressed by log formula and it is more convenient to decide the threshold. 2) The shot boundary detection algorithm for abrupt transition gives good result. The simulation result shows that the proposed algorithm is promising.

However the automatic video partition can be implemented where in gradual transition, camera fabrication, special events and so on can be incorporated.

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