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Graduation Project 1

Report

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Abstract :

Colorization is the process of adding colors to grayscale images. This is done to restore or enhance old films or photographs. As most of Colorization techniques requires user interactions which is an expensive and time consuming process. In this Project we are trying to implement a fast and effective fully automated technique for coloring the gray scale image sequences (videos). The Algorithm can be explained as follows each video consists of multiple scenes and each scene consists of some similar frames in each frame we detect the objects in it using different techniques of pattern recognition and classification.

These techniques operate on the assumption that neighboring pixels with similar intensities should have similar colors. But the only disadvantage of this strategy is that the user has to interact for each frame in which a new object enters the scene which can be often and hence be a high load on the user. so , we assume that there is a frame which contains all the objects of the scene. We call this frame as the Most Informative (MI) frame. We propose colorizing this MI frame by using an existing static image colorization method followed by propagation of colors from colorized MI frame to remaining frames based on the motion vectors between frames.

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1. Introduction :

Colorization is a term introduced by Wilson Markle in 1970 to describe the computer-assisted process he invented for adding color to black and white movies or TV programs. The term is now used generically to describe any technique for adding color to monochrome stills and footage. Automatic colorization process has got more attention from 1980s, like it found its market. And with colorization we are able to revive the past with our classical movies and animations which will find a path through the new generations.

As Colorization is the process of addition of colour to a black and white video or image. A gray scale image is a scalar but A colored image is a vector valued function often represented as three separate channels. So, the colorization process requires mapping of a scalar to a vector (r,g,b) valued function which has no unique solution. This process is found to be too expensive and time consuming in the past and the cost of colorizing a video sequence is directly proportional to the time that it takes to color each frame, so it is highly desirable to have a system that is not unduly expensive.

The algorithm starts with some sample points marked and colored by the user called “seeds” in the first frame or the Most Informative frame these colors are spread to the bounded surrounding regions (or objects as we are using object detection algorithms) using an optimization technique using a quadratic cost function. Then using Optical Flow technique we estimate the transitions between frames within the same scene. Hence, our colorization strategy requires pre-segmenting the entire video into several scenes the several frames.

2. Market Survey :

we have gathered information related to colouring programs and conducted an in-depth research to investigate the market and assess our position should we enter it. We have analysed potential buyers, how the market is expanding, what are the key challenges, and similar products that already exist in the market and how we are going to gain a competitive advantage over them.

2.1 Intended Customers :

Our intended users are mainly the graphic artists who needs to colorize movies and videos with less manual effort , Also some old people who loved the black and white old movies and wish to revive the past , they will be able to watch these movies coloured with better quality, also some young people can watch these movies as a new movies for entertainment.

2.2 Current Market :

This section introduces the similar products to our project. It presents functional, non-functional specification and limitations of each product like :

1- **Algorithmia :** colouring photos and videos with a great accuracy but only small videos (scenes).
2- **EPICOLOR :** colouring videos with grate accuracy but has a very hard user interface
3- **PaintsChainer :** select an image (gif, jpg, png ,tiff) then add a hint information using coloured pen then click the colorize button. But it can only colour images but can’t colour videos.
4- **Photoshop :** the most popular tool but it is not automated also it colours images only.

3. Feasibility Study :

3.1 Product Description:

Our project will help graphic artists to colorize films with less manual effort. As our program will generate an automated colorized film given a black and white film. This could be done by dividing the film into scenes each one consists of some similar frames with only small changes between them.

Throughout these frames we try to get the most informative frame which is the frame that contains the largest number of edges and objects.

Figure 1: Different Frames of same scene

After getting our Most informative frame we set it as the initial frame to be coloured. And once we colour this frame we propagate though the other frames of the scene and it seems to be easier in colouring as it has less objects and complexity.

Figure 2: Different Frames with more complex objects

3.2 Technology Considerations:

We are going to use a supervised machine learning algorithm (self-supervised learning) using neural networks (CNN) to get the best object recognition accuracy in order to facilitate the colouring algorithm and then getting lower user interactions and making the process more automated.

Also we should use some image processing algorithms like filtration to remove noise effects and edge detection algorithms to segment the different objects inside the frame.

3.3 Marketing Strategy :

Our project will use a focus marketing strategy which is a marketing strategy in which we concentrate our resources on entering or expanding in a narrow market or industry segment.

A focus strategy is usually employed where the company knows its segment and has products to competitively satisfy its needs. Focus strategy is one of three generic marketing strategies.

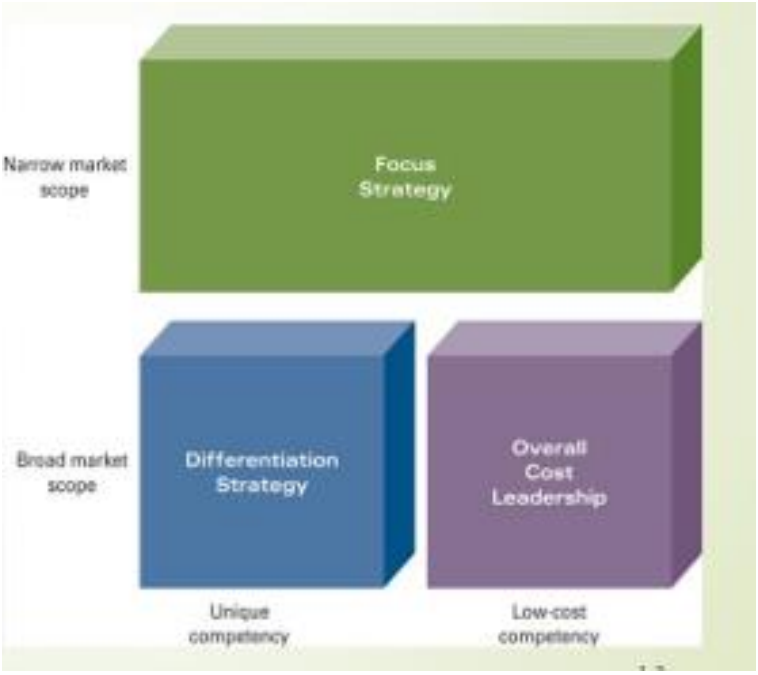

Figure 3: Porter`s Three Generic Strategies

In our project we are targeting the graphic artists (designers) who wants to colorize the old black and white movies and also the past lover people who needs to revive the vintage past.

3.4 Schedule :

Our project time table will be as follows:

1- August : Team Formation
2- September : First meeting with our supervisor and starting our researches for selecting an idea
3- October : Selecting an automated web code generation idea using a web page image.
4- November : Changing our project idea to colouring films as we found it more applicable unlike the automated web code generation which will be done with very low accuracy due to the variations of many web pages.
5- December : Starting to read more papers about Colouring videos and how can we implement such an idea.
6- January : Starting implementation of Project and Gathering more technical information
7- February : Pre-Processing and determine the Most Informative Frame also segmentation of objects
8- March : Colouring the Most Informative Frame
9- April : estimate the transitions in colours between frames within the same scene
10- May : Colouring a full video with different scenes and done with the thesis

Upon approval of this project a more detailed schedule will be created to include all tasks and deliverables.

4. Block Diagrams and Technical Aspects:

The proposed system for colorization of scene I(n) mainly consists of three parts:

a) Segmenting videos into different Scenes then segmenting Scenes into Frames;
b) Counting the number of objects in each Frame
c) Selecting The Most Informative Frame (MI)
d) Colouring the MI frame;
e) Optical flow (OF) computation
f) Propagation of colour;
g) Refinement for colorizing the remaining pixels

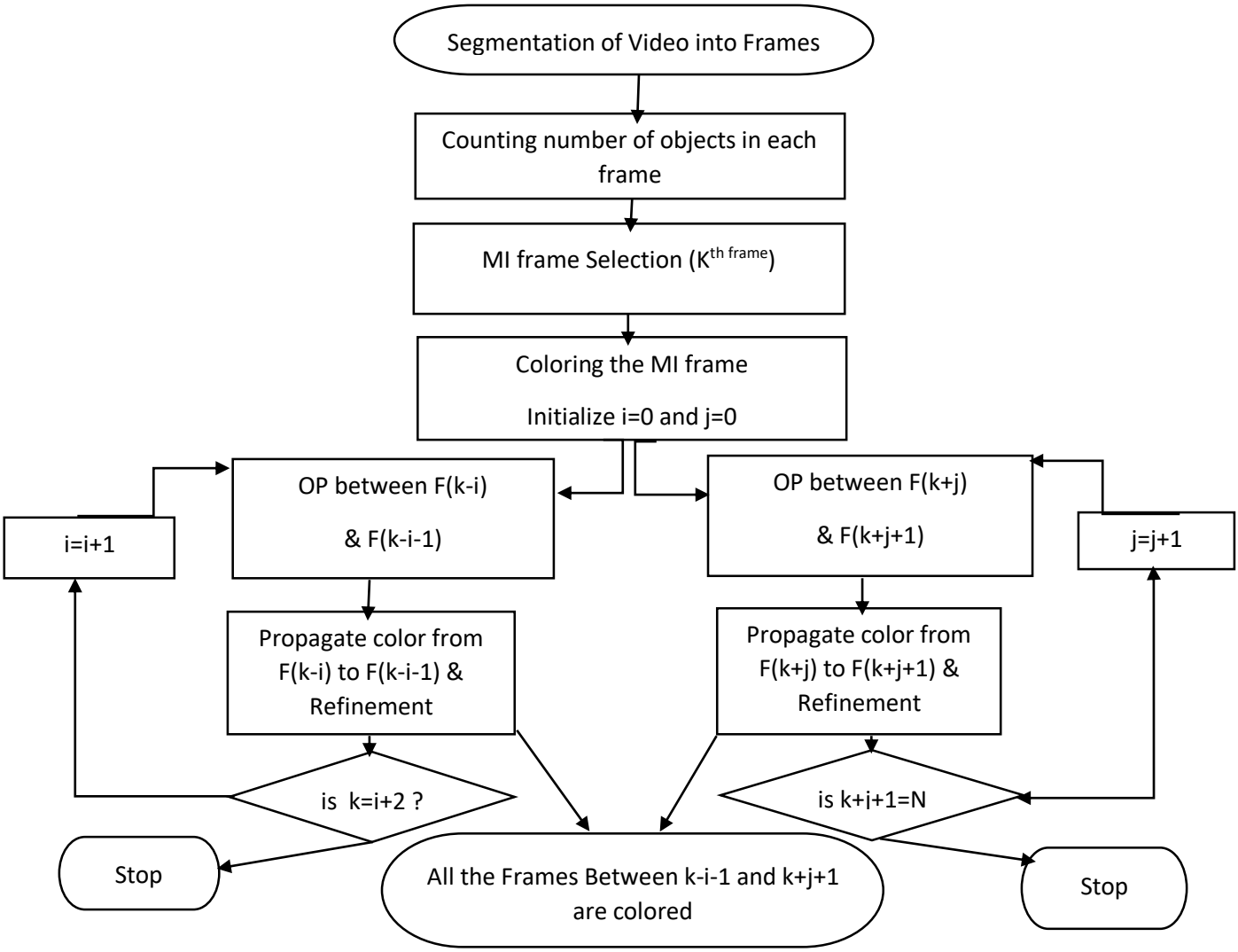

Figure 4: Flow chart of the colorization scheme, N is the number of frames in the scene

4.1 Pre-Processing and Segmentation :

Initially the input to our program is a video with different Scenes, First we should divide this video into separate scenes based on some thresholds in changes between frames, then each scene will have some similar frames. After that we deal with each frame to first we make some pre-processing on the image to remove the noise and then we should detect and recognize the objects inside it and count them for each frame.

4.2 Most Informative Frame Selection :

The MI frame is defined to be the frame which contains maximum number of objects present in that scene. As we are able to determine the objects after we are done with the segmentation process using edge detection techniques. And this frame would be our first frame to be coloured.

4.3 Colorizing the MI frame :

After the section of MI frame, we colorize the MI frame using a scribble based colorization process as we try to recognize the objects inside the frame and decide their colour but sometimes it is hard to determine the object colour so we ask the user to give us a hint as a sample coloured points called “seeds”, then we are able to colour the frame using grey level intensities of neighbour pixels and edge detection techniques.

4.4 Optical flow (OF) computation:

Optical flow (OF) computation is a standard technique to estimate the motion field between two consecutive frames. OF Is computed under the assumption that the brightness of the object remains constant from the initial point in the current frame towards the latest position in the next frame.

The brightness constancy assumption is very sensitive to brightness changes that often appear in real cases. Therefore, it is important to introduce small variation of intensities within the initial intensity value itself. This is done via a gradient constancy assumption.

4.5 Propagation of colour through different frames :

This is the main task in the colorization process. We assign or propagate the color to a pixel in the current frame from its corresponding location in the neighbouring frame. For example, let us consider the right loop. In the first iteration (j=0), the colors of pixels in I(k+1) are found from the colors from I(k), which is the MI frame, according to the motion between the frame pairs. Likewise, in the next iteration (j=1), the pixels in I(k+2) will inherit colors from I(k+1) according to the motion between these frame pairs. This process repeats until the last frame (N). A similar process is followed to colour frames which are left neighbours of the MI frame in the left loop.

4.6 Refinement :

It is possible that some pixels are missed in the process of colour propagation between the frames. Colorizing them is the refinement process. This is based on a test for similarity between the grey values of the pixel to be colourized (missed pixel) and its neighbours which are already colourized.

But If a set of connected pixels are missing and the size of this cluster is more than 5x5, then it either signals the introduction of a new object into the scene or shadow formation due to a change in illumination. This is best resolved by involving the user.

5. Conclusion :

The process of colorization remains a manually intensive and time consuming process. In this project we have suggested a method that helps graphic artists to colorize films with less manual effort. We propose a framework which capitalises on the notion that not all frames will have maximum information together with the fact that frames of a scene are related by a motion field. Thus, an artist needs to colour automatically selected most informative frames (1 per scene) which is subsequently propagated using an optical flow-based algorithm. With the current framework, little more user effort is needed when the video contains more objects not all of which may be present in one frame such as capturing a scene with rotating camera or a still camera capturing a busy road (surveillance videos) scene. In such scenarios also, user effort for the proposed method is far less than that of other methods. Our future work aims at colorization of these kind of scenes with least user interactions.

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