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# Significance of Projection and Rotation of Image in Color Matching for High-Quality Panoramic Images used for Aquatic study

**Kazi Kutubuddin Sayyad Liyakat**

*Department of Electronics and Telecommunication Engineering, BMIT, Solapur (MS) India.*

*Email: firozkazi.26681@gmail.com*

***Abstract: An effective method for stitching marine images together to produce 360-degree circular panoramas of the highest quality. Lengthy, 360-degree image sequences with source photos that have extremely varied colours and luminances have an issue with colour and brightness correction. The use of colour matching reduces both the colour disparities between adjacent images and the overall colour correction for the entire sequence. For the brightness and chrominance components of the source images(marine), respectively, we apply gamma correction and linear correction in aquatic images applications. Color correspondence and colour difference distribution procedures are used to address the issue of colour consistency in 360-degree panoramic photographs. In order to produce high-resolution and high-quality panoramic photographs for mobile phones, this article incorporates the stitching approach into a panoramic imaging system.***

***Keywords: Mobile; Panoramic Imaging; Stitching; Gamma-Correction; Aquatic; Marine images;***

## 1. INTRODUCTION

*A. Panoramic Images on Mobile Phones*

Modern cell phones have evolved into computational tools with high-resolution cameras, gorgeous colour displays, and potent 3D graphics processors, making it possible to create augmented reality and mobile computational photography applications. The creation and immediate sharing of panoramic photographs on mobile devices are made possible by mobile panoramic imaging [1]. Mobile phones still have several drawbacks, such as low memory and computational capacity, as compared to desktop computers. In this article, we address the issue of colour processing and create a productive 360-degree panorama stitching method that can be used with a camera phone[2].

*B. Related Work*

The work largely entails image stitching, which also includes image tagging, mixing, and colour correction. Color correction is used to even out colour and luminance across the whole image sequence and to minimise colour disparities between source photos. While easy and quick, approaches based on linear models [3] (either in linear RGB or gamma-corrected sRGB) do not provide highly accurate colour correcting. One of the biggest issues with such methods is the colour saturation that occurs throughout the colour correction procedure. Even greater quality can be attained with more involved processing, presuming pixel-perfect registration of the pictures. [4] Image tagging is used to locate the best seams—those where there are the fewest discrepancies between the source photos—and to merge the images together along those seams. By using graph-cut, dynamic programming, or other methods, it is possible to find the best seams[5]. The graph-cut based techniques can locate global optimal seams with random image order, but they have significant memory and processing requirements. On the other hand, techniques based on dynamic programming can quickly and efficiently locate ideal seams while using little memory[6].

For the entire panoramic image, image blending is utilised to minimise colour disparities between the source images and to smooth out colour transitions. High-quality blended images[7] can be produced through gradient domain image [8] blending. However, memory usage and computational costs are significant. Instant picture cloning has recently been developed, using mean value coordinates to distribute colour differences along seams throughout the entire image to be blended. The strategy is straightforward and efficient. It decreases memory usage and quickens the blending process[9-10].

**Present Work**

This research develops an effective picture stitching method for producing high-quality continuous circular 360-degree panoramic marine photographs from on mobile phones [11] based on earlier work on a mobile panoramic photography system [1-2].

By matching the differently exposed marine photos, this research tackles the issue of colour disparities of source images in the marine image sequence[12]. Different photographs are exposed and white-balanced in accordance with the image content, resulting in variations in the brightness and chrominance for the identical items seen in two overlapping neighbouring images[13]. Within the overlapped region, we apply a new gamma correction that matches the luminance content of nearby images and a linear adjustment for the chrominance components. This method produces high-quality results while avoiding the overflows that are present in conventional linear algorithms. We match adjusted averages of brightness and colours in the overlapping regions of source marine images [14–16] to strengthen the approach's resiliency to the accuracy of spatial alignment. Additionally, this method requires less computing, making it ideal for use on mobile devices. Here, we extend it to 360-degree circular panoramas. A 360-degree panoramic image has additional colour constancy restrictions between its starting and ending regions. In order to acquire colour correction coefficients to balance colours and luminance over the whole image[17] sequence, we input information from these two locations into a global colour matching procedure during the colour correspondence process. The transition from the end to the beginning and all other parts of a continuous circular 360-degree panorama have less distinction between them[18]. In order to ensure colour consistency for a circular 360-degree panoramic image, we select an ideal seam between the begin and end portions, merge them together along the seam, and blend the colour differences[19]. In order to create high-quality panoramic photographs, we have integrated the panorama stitching method into a mobile panoramic imaging equipment. We use a variety of image sequences to demonstrate the methodology and achieve successful performance [20].

**Work Flow of the Stitching Approach**

The procedure for the panoramic stitching approach with colour matching is shown in Fig. 1[1]. It develops a sequential process to fuse individual source photos into a panoramic image. We never have to retain the entire big output panorama in memory at full resolution since we can stream the output image to a file, which is crucial for memory conservation. We begin by determining the stitching order for the sequence's source images. Next, we use colour matching to calculate the colour correction factors. We calculate the chrominance component mean values and the luminance component logarithmic mean values for each source image in the overlapped region of neighbouring images. By colour matching with the mean values for each colour channel, an error function in colour correction coefficients can be produced. We derive the colour correction coefficients for each source image after minimising the error functions using a global optimization procedure. Then, using a sequential process, we do image stitching to produce a panoramic image. We apply gamma correction to match the luminance of the current source image and linear correction to match the chrominance. If the image being used is the first image, it is directly added to the panoramic image file by encoding and saving it. If not, we use dynamic programming to discover an ideal seam between the old picture Si-1 and the new source image Si and merge the two together along the seam. We execute picture merging using an error diffusion process to lessen colour disparities between these two photos and smooth colour transitions in the panoramic image. On the Si side of the seam, we compute colour differences and distribute those differences over all pixels. By adding the contributions, we update the colour and brightness values of these pixels. We then encode and save the updated values as part of the panoramic image file. By doing this, we can make the existing panoramic image's colour transitions more seamless. For each source image, this processing is repeated. In order to build a continuous circular 360-degree panoramic image, we finally locate the best seam between the initial and last portions of the panoramic image, merge them together, and use the colour difference distribution procedure to ensure colour consistency. By encoding and saving the merged composite to the panoramic image file, we integrate it into the existing panorama.

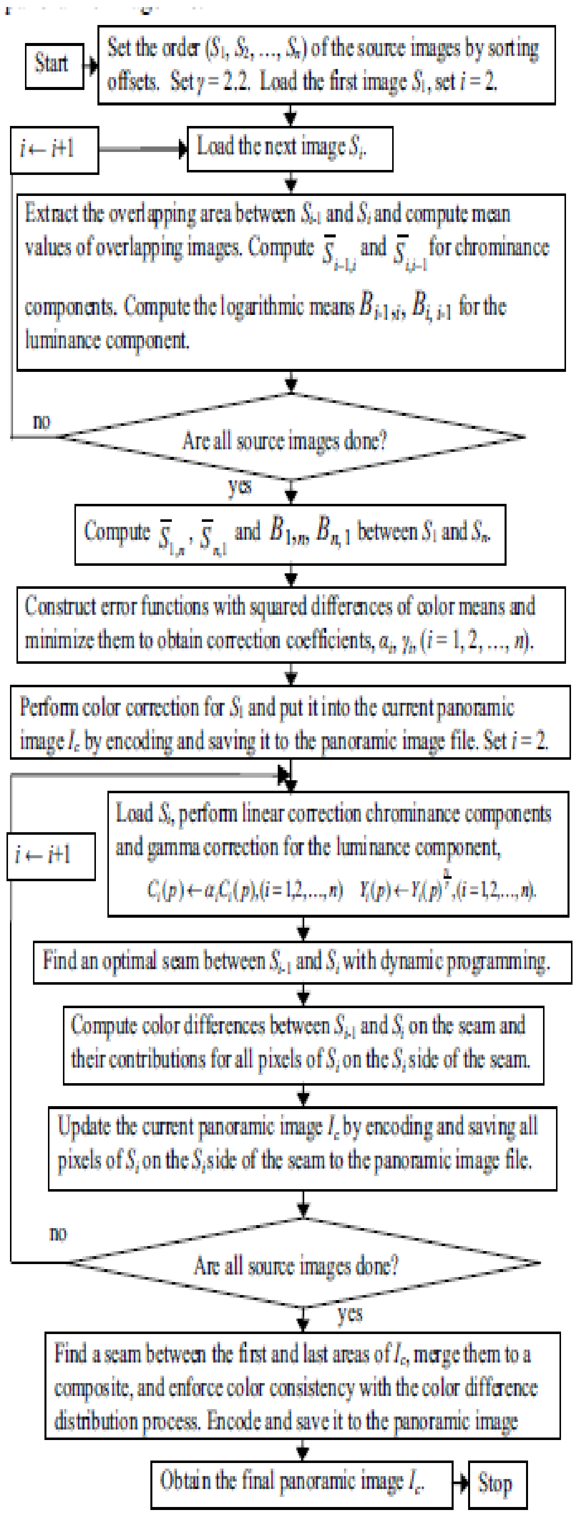



**Fig. 1. Workflow of the panorama stitching with color matching.**

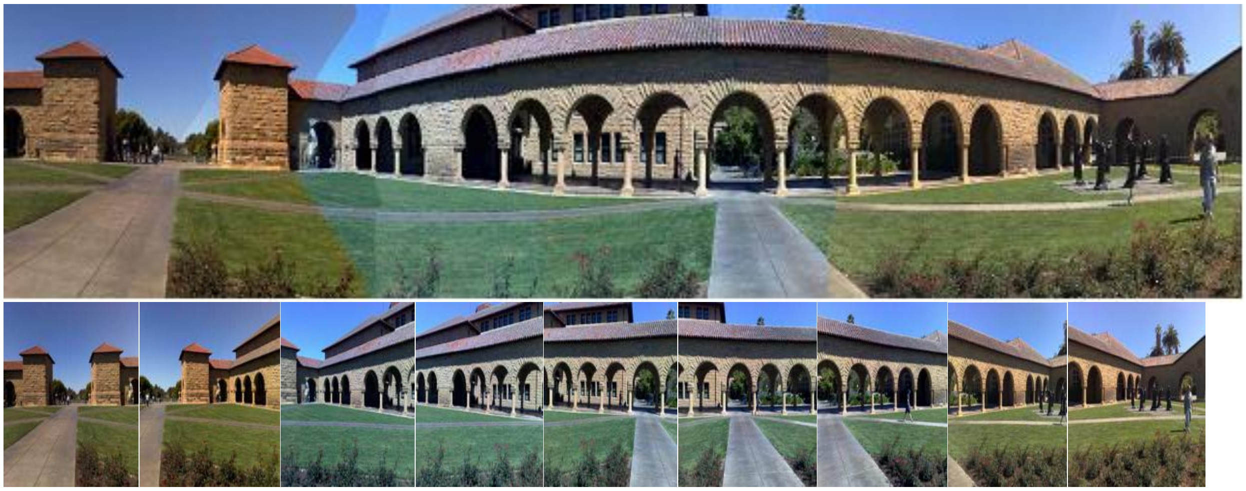


Fig. 2. Image stitching without color processing.

Fig. 3. Result of local linear color correction.

Fig. 4. Color differences between the first and last areas of a 360-degree panoramic image.

**Details of the Image Stitching Approach with Color Correction**

*A. Problem Expression*

Since image parameters are automatically recalculated for each input image during panorama capture, variations in illumination levels result in varying exposure levels in adjacent images, and variations in the distribution of variously coloured objects have an impact on the white-balance settings. As a result, images are produced where the same objects seen in various images appear different, either brighter or darker, or even with different apparent colours. A sample is shown in Fig. 2. Without applying any colour processing, we stitched nine photos of various hues and luminances together to produce the result seen on the top, where the seams and stitching artefacts are plainly visible. The quality and speed of subsequent processes, such as the best seam identification and picture blending, are improved by colour correction, which can minimise colour discrepancies between source photos and create smooth colour transitions for the entire image sequence [22]. The original photos must first undergo colour correction before being stitched together. Color correcting with a linear model is quick and easy. No precise pixel correspondences are required. However, as previously mentioned, there are a number of issues with linear colour correction: the order of source images during the colour correction process as well as the calibre of the first image have an impact on the outcome; pixels are easily saturated during colour correction, especially when the colour correction errors accumulate as we process the image sequence. A sample outcome produced by a linear color-correction method is shown in Fig. 3 [16]. The outcome shows that many pixels, including those in the sky and the road, are saturated and have lost their detail. The panoramic image gets brighter from left to right as a result of accumulated errors. Since the initial image doesn't change, the sequence's colours are twisted by the first image's poor colour choices. Color transitions in the panoramic image are poor since the colour adjustment is done locally. In order to minimise pixel saturation issues, eliminate cumulative mistakes, make the correction process independent of the source images' correction order, and adjust colour and brightness globally over the entire image sequence, we wish to develop a colour and luminance compensation approach. To achieve this, we perform colour and luminance compensation for the source images based on a combination of gamma correction for luminance and linear correction for chrominance, and then use a global optimization process to obtain correction coefficients simultaneously for the entire image sequence. An further issue with colour consistency arises when making a 360-degree panoramic image[10]. A sample is shown in Fig. 4. The image sequence displayed at the bottom in this instance contains a total of 19 source images. The original photographs' hues and brightness are significantly dissimilar. A panoramic image produced using the image sequence can be shown in Fig. 4 (top). The red rectangles illustrate how the beginning and conclusion of the panoramic overlap but have quite different hues. Instead, the hues and brightness have to be comparable. Because they are different in this illustration, the panoramic view appears unnatural. To ensure that the 360-degree panoramic image has consistent colours, our stitching method develops two processes: colour correspondence and colour difference distribution.

*B. Color Correction*

*1) Gamma and Linear Correction Coefficients*

We use gamma correction to match the luminance in the overlapped regions of an image sequence S1, S2, S3,..., Sn and create an error function.,

$$\min E_1 = \frac{1}{2}\left(\sum_{i=2}^{n}(\gamma_{i-1}B_{i-1,i} - \gamma_i B_{i,i-1})^2 / \sigma_N^2 + \sum_{i=1}^{n}(1-\gamma_i)^2 / \sigma_g^2\right), (1)$$

where $\sigma_N$ and $\sigma_g$ are the standard deviations of the normalized color and luminance errors and gamma coefficients. We choose values $\sigma_N = 2.0/255$ and $\sigma_g = 0.5/255$ (when the image value range is normalized to [0, 1]),

$$B_{i-1,i} = \ln\left(\frac{1}{N_{i-1,i}}\sum_p Y_{i-1,i}(p)\right), B_{i,i-1} = \ln\left(\frac{1}{N_{i-1,i}}\sum_p Y_{i,i-1}(p)\right), (2)$$

*Yi-1,i(p) is the luminance value of pixel p in the image $S^0$i-1,i (linearized from the sRGB luminance by raising to the power of 2.2); Ni-1,i is the number of pixels in the overlapped area; and Yi-1,i(p) is the luminance value of the corresponding pixel p in the image S0i-1,i. The gamma coefficients I I = 1, 2,..., n) can be obtained by minimising the error function E1. Similar to this, we can create an error function and use linear correction to match the chrominance in the overlapped regions of the adjacent images.,*

$$\min E_2 = \frac{1}{2}\left(\sum_{i=2}^{n}(\alpha_{i-1}\bar{S}_{i-1,i} - \alpha_i \bar{S}_{i,i-1})^2 / \sigma_N^2 + \sum_{i=1}^{n}(1-\alpha_i)^2 / \sigma_g^2\right). \quad (3)$$

Where $S_{i-1,i}$ and $S_{i,i-1}$ is the chrominance mean value of image $S^0_{i-1,I}$ and $S^0_{i,i-1}$ image respectively,

$$\bar{S}_{i-1,i} = \frac{1}{N_{i-1,i}} C_{i-1,i}(p), \bar{S}_{i,i-1} = \frac{1}{N_{i-1,i}} C_{i,i-1}(p), \quad (4)$$

$Ci$-1,$i$($p$), $Ci$,$i$-1($p$) are the chrominance values of pixel $p$ in overlapping images $S^0_{i-1,I}$ and $S^0_{i,i-1}$ ($i$ = 1, 2, …, $n$) are linear correction coefficients. Solving this quadratic objective function, we can obtain the linear correction coefficients $\alpha_i$ ($i$ = 1, 2, …, $n$).

*2) Color and Luminance Correction*

For each source image, we perform gamma correction for the luminance component,

$$Y_i(p) \leftarrow Y_i(p)^{\frac{\gamma_i}{\gamma}}, (i = 1,2,\ldots,n), \quad (5)$$

Where $\gamma$ is the gamma coefficient used above for linearization of the *sRGB* color space, and linear correction for the chrominance components,

$$C_i(p) \leftarrow \alpha_i C_i(p), (i = 1,2,\ldots,n). \quad (6)$$

*3) Color Correspondence Process*

We develop a colour correspondence method for building 360-degree panoramas. There is a region here where the beginning and ending areas overlap. We extend the global colour matching procedure to include the brightness and colour information in these regions. The error function (1) changes to become, for luminance matching.,

$$\min E_3 = \frac{1}{2}(\gamma_1 B_{1,n} - \gamma_n B_{n,1})^2 / \sigma_N^2 + \frac{1}{2}\sum_{i=2}^{n}(\gamma_{i-1} B_{i-1,i} - \gamma_i B_{i,i-1})^2 / \sigma_N^2 + \frac{1}{2}\sum_{i=1}^{n}(1-\gamma_i)^2 / \sigma_g^2 . \quad (7)$$

The brightness between the first and last photos in the image sequence corresponds to the first item in error function (7). We gain new gamma correction coefficients by solving this function. A new error function for new linear correction coefficients can be made by adding chrominance matching between the first and last photos to (3) in a similar manner. The beginning and finishing regions of the 360-degree panoramic image have consistent colours thanks to the brightness and colour matching..

*C. Image Labeling*

In order to discover the best seams in the regions where source photos overlap and merge together to create a panoramic image, we employ the labelling method outlined by [12].

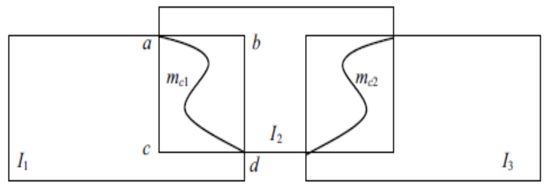



**Fig. 5. Optimal seam finding for image labeling.**

The labelling procedure is shown in Fig. 5. This method uses dynamic programming to carry out the best seam-finding procedure. After separating the area of overlap between images I1 and I2, shown in Fig. 5, we create an error surface using the squared colour differences in the overlapped area. Row by row, we examine the error surface and calculate the cumulative minimum squared difference. Using dynamic programming and the cumulative minimum squared difference, an optimal path, mc1, can be identified. In order to combine the source photos, we employ the best path as a seam. In order to conserve memory, the source photos are sequentially stitched together to create the panoramic image. In order to build a continuous circular 360-degree panoramic image, we also need to identify an ideal seam between the panoramic image's beginning and ending regions and merge them along the seam.

*D. Image Blending*

*1) Color Blending*

The colour disparities between the source photos throughout the entire image sequence can be minimised using colour matching. Smooth colour transitions are possible throughout the entire panoramic image. The colour matching, however, only offers a close match, leaving still discernible hue discrepancies. Image blending can provide the panoramic image with smooth colour transitions and further reduce colour discrepancies. We employ a powerful blending strategy that has a quick processing time and great blending quality.

Let D1, D2,..., Dn be the colour differences at those locations between the overlapping photos, as shown in Fig. 6, p1, p2,..., pn be the n points on the seam mc, and q be a pixel of the blended image. Then, by using,, we interpolate the colour differences at pixel q.,

$$D(q) = \sum_{i=1}^{n} w_i(q) D(p_i), \qquad (9)$$

where the weights are the inverse coordinate distances to the boundary pixels, normalized so that they sum up to 1:

$$w_i(q) = \frac{1/\| p_i - q \|}{\sum_{j=1}^{n} 1/\| p_j - q \|}. \qquad (10)$$

We add these changes to the pixels in the blending area.

$$C(q) \leftarrow C(q) + D(q), \qquad (11)$$

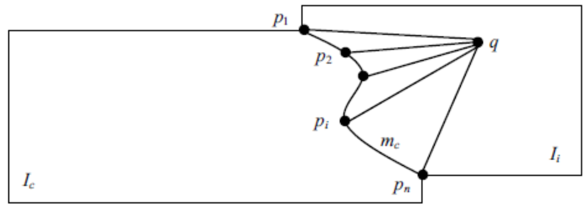



Fig. 6. Mean value coordinates based image blending.

*2) Color Difference Distribution Process*

The source photos are sequentially stitched to the panoramic image during the sequential image stitching procedure. To maintain seamless colour transitions, the preceding image's colours are reflected in the colours of the stitching image. In actuality, this means that it's quite uncommon for the colours at the panorama's finish to coincide with those at its beginning. When creating a 360-degree panorama, we do not want the colours to change as the image rotates. To ensure colour constancy when the panorama is connected from the end back to the beginning, we develop a colour difference distribution mechanism.

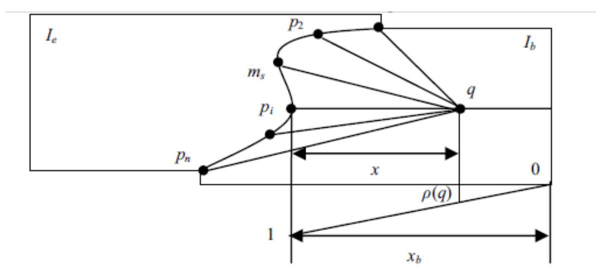



Fig. 7. Color difference distribution for 360-degree panoramic images

The colour distribution method for a 360-degree panoramic image is shown in Fig. 7. Two overlapping picture patches, Ib and Ie, were taken from the panoramic image's beginning and conclusion, respectively. Using the method outlined in Section III.D, we identify an ideal seam ms and combine them along the seam to produce a composite image. We leave picture Ie on the left side of the seam untouched and distribute colour discrepancies on the seam to image Ib on the right side of the seam in order to make the colours similar in these two images. Since picture Ib is taken from the beginning of the panoramic image, we must maintain the colour balance between image Ib and the original portion of the panoramic image by leaving the end of image Ib's colour unchanged. The distribution of colour differences is seen below.

The colour variations between the images are distributed to the blending area using image blending, and the colour changes are steadily reduced in relation to the distance from the seam until they are zero at the end of Ib. We use - to lessen the colour of pixel q in the blending region on the active scan line.

$$C(q) \leftarrow C(q) + \rho(q)D(q), \qquad (12)$$

where, $D(q)$ is calculated with Equation (9); $\rho(p)\epsilon\{0,1\}$ is a ratio which changes linearly from 1 on the seam to 0 at the end of the blending area,

$$\rho(p) = 1 - \frac{x}{x_b}; \qquad (13)$$

On the current scan line, x is the horizontal separation between pixel q and the seam, and xb is the separation between the seam and the end of the blending region. To build a continuous circular 360-degree panoramic image, we combine the composite image with the original panoramic image after updating all of the pixels in the blending region.
We chop the continuous circular panoramic image along a vertical line in order to store the panoramic image in a 2D array and display it conveniently.
The outcomes of the picture stitching method with colour matching for the identical source photos displayed in Figs. 2 and 3, respectively, are presented in Figs. 8 (top) and (middle). According to the results, stitching artefacts are eliminated, colour transitions in the panoramic photos are smoothed, and colour discrepancies between the source images are decreased. All issues with linear correction are prevented. The outcome of the picture stitching method using the colour correspondence and colour difference distribution methods for the identical source photos as those in Fig. 4 is depicted in Fig. 8 (bottom). The panoramic photo has considerably better quality than the previous one. It has better transitions over the entire panoramic image and much more consistent colour in the starting and ending portions.

## 2. APPLICATIONS AND RESULT ANALYSIS

In order to produce panoramic photos in aquatics with excellent clarity and resolution, the panorama stitching technique has been integrated into a mobile panoramic photography system. It works well with source photos that have extremely diverse hues and luminance, according to tests with various image sequences. The findings in this section were acquired using a smartphone having a 600 MHz processor, 256 MB of RAM, 768 MB of virtual memory, and a 3.5-inch widescreen touch display. Other mobile devices with less powerful capabilities can also run it. The outcomes are pleasing.

### *A. Performance Measurements*

Using image sequences containing source photos of various resolutions, including 1280960, 20481536, and 25761936, we assessed the calculation time of the stitching approach on the mobile phone mentioned above. For each resolution, there are two image sequences of 5 and 10 photographs, respectively.
For instance, the total stitching time for 10 source photos at a resolution of 1280 x 960 is 13.37 seconds. They each require 0.97 seconds, 6.96 seconds, and 5.44 seconds for the colour correction, labelling, and blending, respectively.

### *B. Color Correction and Comparison with Other Approaches*

A comparison of panoramic photos produced using various colour and brightness correction techniques is shown in Figure 9. In this application, the image sequence in Fig. 9 has 17 source images (e). The image series demonstrates how drastically varied the colours and luminance of the source photographs are. Without any colour and luminance processing, the source photos are simply stitched together, but the disparities in colours and brightness can still be seen in the composite image. To lessen these disparities, colour correction and transition smoothing are required.

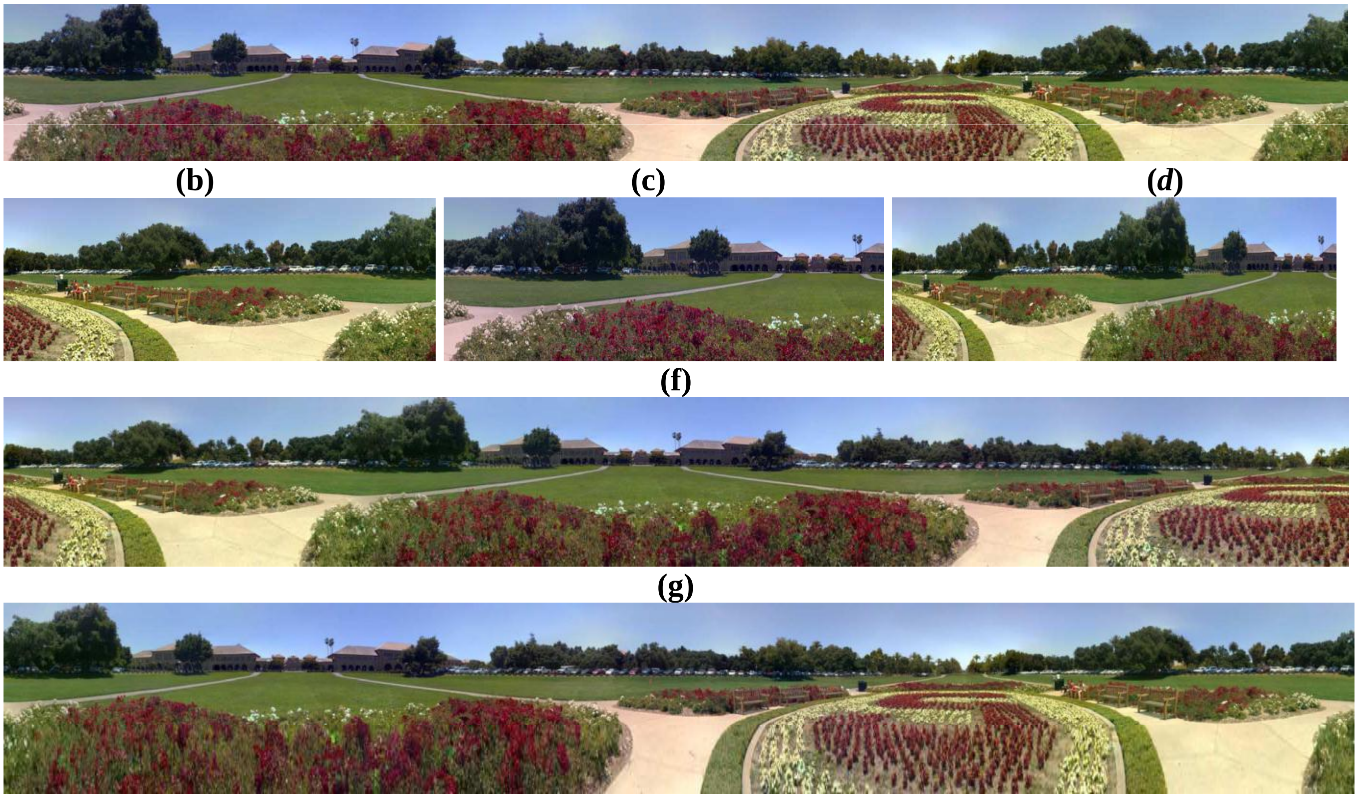
A panoramic image produced through image stitching and the local linear colour correction described in [3] is shown in Fig. 9 (a). The result shows that there is pixel overflow in a number of locations, including the sky near the tower, the road near the light pole, and more. After colour correcting, the entire image is overly bright and many details have vanished. Poor colour transitions may be seen across the image, but particularly on the left and right sides.

The panoramic image in Fig. 9 (b) was produced using image stitching and the linear models in the YCbCr colour space described in [4] for colour correction. Similar issues exist as the outcome depicted in Fig. 9. (a). The sequence of the source photos in the colour correction process has an impact on the final product's pixel saturation in many regions, loss of the majority of details, poor colour transitions over the entire image, and poor colour transitions.

The result of image stitching using the global linear colour correction method described in [5] is shown in Fig. 9(c), where the method is solely employed for luminance correction. Here, we employ it for sRGB colour space colour correcting. We can see from the outcome that colour correction has resolved any issues with colour overflow. The panoramic image's quality is still lacking, though. Some source photos have been overly adjusted,

Fig. 9. Comparison of results created by different color correction approaches. From top to bottom, (a) Local linear correction in [3], (b) Color correction by the approach in [4], (c) Global linear correction [5], (d) Gamma correction using color matching, (e) Source images.

**(a)**




(h)

Fig. 10. Construction and color consistency of 360-degree panoramic images.

such that areas of the image on the extreme left and right become overly black. The source photos at the start and end of the image sequence are too bright, which is the cause. The method applies an excessive amount of correction to these source photos in order to maintain the colour harmony and brightness of the entire panoramic image.

A panoramic image produced using image stitching and gamma-corrected colour mean matching is displayed in Fig. 9(d). In the YCbCr colour space, we apply linear correction to the chrominance component and gamma-correction to the luminance component. It is the best outcome of these cases, as can be seen from the panoramic photograph. All of the issues listed above have been resolved. The modifications are not overly pronounced, and there is no colour overflow. The entire panoramic image has excellent colour harmony and colour transitions. The final product has all of the original photos' details. No areas that are very bright or too dark result from colour correcting.

*c. Construction of 360-degree Panoramic Images*

Fig. 10 illustrates how to use various procedures to create continuous circular 360-degree panoramic photographs for an image series taken in an outside setting. The image sequence consists of 19 source photos with a wide range of luminance and hue. Some pictures have vivid colours, while others have garish hues. This image sequence, which can be used to test colour correction and image stitching methods, is depicted in Figure 10(i).

The panoramic image produced by the panorama stitching procedure is shown in Fig. 10(a), along with image labelling, colour correction, and image mixing without colour consistency processing.

From the outcome, it is clear that the panorama stitching method is highly efficient and can be used to combine numerous photographs with vastly disparate colour and brightness to produce high-resolution and high-quality panoramic images. When creating a panorama, colour and brightness disparities in the source photos are minimised, unrealistic source image colours are adjusted, and colour transitions throughout the whole panorama are smoothed.

A 360-degree panorama is shown here. In the panoramic image's beginning and finishing regions, there is an overlapped section. As can be seen from the result in Fig. 10 (a), although these sections cover the same landscape, the colours and brightness are not constant. One of the key issues we discuss in this study is this one. This issue can be resolved using the colour correspondence and colour difference distribution processes that are discussed in Sections III.B and III.D, respectively. When processing the colour consistency of a 360-degree panorama, we extract two picture patches from the beginning and finish of the panorama, respectively. They are depicted in overlapping sections of Fig. 10 (b) and (d). Fig. 10 displays the remaining portion of the panoramic picture Ic (c). We can locate the best seam between these two picture patches using the 360-degree panorama labelling method discussed in Section III.C, and then combine them to create a composite image Ie. We employ a colour difference distribution procedure to blend the colour differences on the seam to the blending region in order to eliminate stitching artefacts brought on by the colour disparities between these two areas and create colour consistency between the composite image Ie and image Ic. Fig. 10 displays the outcome of the blended composite image Ie produced using the 360-degree panoramic colour consistency approach (e). The end result reveals that there is no visible seam between these two image patches, that colour differences are eliminated, that colour changes are gradually reduced from left to right, and that there is no colour change at the composite image's end (Ie), allowing it to match the beginning of image Ic.

The outcome of adding the composite image Ie to the start of the remaining panoramic image Ic to produce a precise 360-degree panoramic image If is shown in Fig. 10(f). The outcome shows that the 360-degree panorama colour consistency technique is quite effective because the composite image Ie and the rest of the panoramic image Ic match precisely without any discernible artefacts. Since the panoramic image's beginning and conclusion are simply separated from one another, the result also demonstrates that there are no artefacts between them. The 360-degree panoramic image created has significantly greater colour consistency between the beginning and finishing sections and the colour transitions are seamless across the whole panoramic image as compared to the original panoramic image shown in Fig. 10(a).

The results of adding the composite image Ie to the end of the panoramic picture Ic are shown in Fig. 10 (g), and in Fig. 10 (h), half of the composite image Ie is added to the start and the other half is added to the end of the panoramic image Ic.

Additional 360-degree panoramic images made using the stitching method and colour matching are displayed in Fig. 11. Figure 11 (top) displays the outcome for a different outside setting, whereas Figure 11 (bottom) displays the outcome for an indoor scene. The results show that the panorama stitching method may be utilised to produce 360-degree panoramic photographs of excellent quality with good colour transitions for both indoor and outdoor settings and good colour constancy in the beginning and finishing areas.

Fig. 11. More 360-degree panoramic images obtained by the panorama stitching approach.

## 3. CONCLUSIONS

We provided an image stitching technique that may be used to produce 360-degree continuous circular panoramic photos with excellent colour constancy and colour transitions. The strategy entails image blending, image tagging, and colour correction. Gamma correction is used to even out colour and luminance across the whole image sequence and reduce colour variations between source images. By colour matching in the overlapping parts of the source photos, the gamma coefficients are produced. Pixel saturation issues can be prevented during the colour correcting process, which is one of the key benefits of gamma colour correction. The source photos are combined into a panoramic image using an optimal seam finding algorithm that identifies the best seams in the overlapping regions of the source images. Dynamic programming uses a quick, low-memory-usage approach to find seams in the best way possible. To further eliminate colour disparities between the source photos and to smooth out colour transitions over the entire panoramic image, an image blending technique is applied. To create high-quality blended images quickly and with little memory usage, we distribute colour differences on the seams to the pixels in the blending areas. The 360-degree panoramic image's inconsistent colour between the beginning and conclusion has been fixed. Neighboring photos may have varied hues and brightness during image capture due to variations in scene illumination and the camera's view angle. The initial and last shots in a long image sequence that is being processed to create 360-degree panoramic images usually have highly varied colours and brightness levels. The panoramic image exhibits a colour discontinuity if there is no additional colour processing. To solve the issue, we created two processes: colour correspondence and colour difference distribution. To balance colours over the whole image sequence, we add information about colour matching in the panoramic image's beginning and finishing regions to the colour correction procedure in the colour correspondence step. To ensure colour consistency, we distribute the colour disparities from the seam to the blending region after identifying an ideal seam between the beginning and finishing sections, merging the two together along the seam to generate a continuous circular panoramic image.

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