An Improved Electronic Image Stabilization Algorithm
Based on Gray Projection

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Keywords: Electronic image stabilization, Gray projection, Gray level plane.

Abstract. The electronic image stabilization algorithm based on gray projection is a fast method to stabilize the image. The disadvantage of finding this method in the study is that the accuracy is not high enough, especially in the case of complex images and local motion. A new method of combining gray level planes and grayscale projection algorithms is proposed. This method calculates the results accurately by calculating the mean of the offset of multiple bit planes. The experimental results show that the method can reduce the computational error effectively.

Introduction

Urban traffic real-time monitoring system is an important part of intelligent transportation. At the intersection and the important sections, more and more monitoring equipment is installed to monitor the traffic. Traffic monitoring video is an important source of data for traffic analysis, congestion prediction and evaluation, etc. Therefore, image processing is one of the hotspots of intelligent transportation. Electronic image stabilization techniques include a variety of methods, such as gray projection method, block matching method, representative point method, and phase correlation method, in which the gray scale projection method is the fastest and most widely used.

At present, there are a lot of research on gray projection methods, including algorithms and application platforms [1, 2]. Wang (2012) studies electronic image stabilization algorithm based on gray projection block matching. The proposed method summarizes the advantages of grayscale projection algorithm with fast computing speed and block matching algorithm with high accuracy of matching, and has a good image stabilization accuracy and image stabilization speed by experimental verification [3]. Zhao (2013) studies the relationship between clustering and grayscale projection techniques, and an electronic image stabilization method combining clustering and gray projection is proposed. The motion estimation of the rotation angle is estimated using wavelet transform and clustering methods and the motion estimation of the translation is calculated using the gray scale projection algorithm [4]. Gu (2013) describes problems with the effect of poor image stabilization and the possibility of producing erroneous image stabilization when the gray scale projection algorithm is applied to the presence of local motion targets. On the basis of analyzing the basic theory of gray projection, an improved gray projection algorithm is proposed, and this method can solve the situation of the existence of moving objects [5]. CZ You (2015) studies the time-consuming problem when the gray-scale projection algorithm was in a stable image. In the case where the image stabilization effect is not affected, in the case that the image stabilization effect is not affected, this method distinguishes the image and uses the improved algorithm to solve the gray scale projection vector, and uses the mean filter to get the global motion vector to realize the motion compensation [6]. Gong (2017) studies the problem of insufficient accuracy of grayscale projection. He finds that the gray scale projection algorithm accuracy would drop when dealing with gray value of a single, poor contrast image sequence. And an electronic image stabilization algorithm based on block gray scale projection is proposed [7]. Fan (2017) studies the mine car camera system. In order to quickly and accurately stabilize the jitter image obtained from the system, an electronic image stabilization algorithm based on down-sampling gray-scale projection is proposed. This method is superior to traditional gray-scale projection algorithms in terms of accuracy and computation time [8].
In the above view, it is shown that the research direction of this algorithm is to improve the image stabilization accuracy. Therefore, this paper focuses on the development of this method and proposes an improved algorithm for gray image projection based on bit-plane.

**Electronic Image Stabilization and Gray Projection and Bit-plane**

**Electronic Image Stabilization Based on Gray Projection Algorithm**

EIS [9] is a way that we can use the method of digital image processing to make images stable. It includes digital image acquisition through electronic equipment DV, DC, camera, digital image processing and digital image output and so on.

Electronic Image Stabilization Based on Gray Projection Algorithm

![Flow chart of electronic image stabilization.](image)

GPA includes four steps as follows:

*Step 1:* It is necessary to change the image into grayscale image.

*Step 2:* It will get the row and the column projecting value through gray projection operation. Computing formula is as follows.

\[
\text{row} \ (i) = \sum_{j=1}^{n} \text{pic} \ (i, j) \ ; \ \text{column} \ (j) = \sum_{i=1}^{m} \text{pic} \ (i, j)
\]

(1)

*row(i)* is the row projecting value on *i* line. *column(j)* is the column projecting value on *j* series. *pic(i, j)* is the gray value on the point of *i, j*.

*Step 3:* The image dithering offset will be got through correlation operation. This formula is as follows.

\[
C(w) = \sum_{j=1}^{n} \left[ \text{column} \ (j + w - 1) - \text{column} \ (M + j) \right]^{2} \ ; \ 1 \leq w \leq 2M + 1
\]

(2)

*C(w)* is the correlation operation value. *M* is the maximum extent of detection jitter in image. *w* is the *w* when *C(w)* is minimum.

Now, the offset can be computed through the following formula. The column offset is computed, so is the row offset.

\[
motion \ c = M + 1 - W_{\min}
\]

(3)

*Step 4:* Move the dithering image *motion*, and *motion*, volumes in the opposite direction, and then we can acquire the stable image.
Gray Level Bit Image Separation Method

The image can present different information if the image is graded according to the grayscale level, and the different gray level plane can reflect the different information that the grayscale image cannot be shown [10].

An image of a visible light contains a lot of information, where the grayscale information reflects the degree of shading of each pixel. The images obtained by the visible light device are usually saved based on the RGB color model. If you want to get the gray level information of each pixel from the RGB image, it is generally necessary to calculate the R, G, and B values corresponding to each pixel of the image through the Eq. 4

$$G(x, y) = \frac{R + G + B}{3}$$  \hspace{1cm} (4)

Where $G(x, y)$ is the gray value of the point $(x, y)$ (in the form of decimal), and R, G, and B are the values of red, green, and blue, respectively.

After obtaining the gray scale value, the gray level plane can be extracted from the grayscale image. The specific steps are described below:

**Step 1:** The gray value of each pixel in the image is converted from decimal to binary, and the value can be divided into eight gray levels. For example, if the gray value is 255(decimal), then the gray value can be expressed as 11111111(binary). The conversion equation is as follows:

$$G(x, y) = b_{k-1}2^{k-1} + b_{k-2}2^{k-2} + \cdots + b_12 + b_0$$  \hspace{1cm} (5)

Where $b_k = 1$ or $0$ and K is gray level (The default value of K is equal to 8).

**Step 2:** After obtaining the binary gray value, only the value of each bit corresponding to the binary is extracted, and the gray bitmap can be obtained from the newly formed image. The conversion equation is as follows:

$$g_k(x, y) = b_k2^{k-1} \hspace{1cm} 1 \leq k \leq K$$  \hspace{1cm} (6)

Among them, $g_k(x, y)$ is the k-th level gray value.

Research on Combination of Gray Bit Plane and Gray Projection Algorithm

First of all, the two images (reference frame image and current frame image) are converted to eight gray level planes, as shown in Figure 2. (In order to better observe the effect, the image only appears vertical jitter.)
Second, each set of gray bit plane is calculated by the electronic image stabilization algorithm based on gray projection. Specifically includes two steps: gray projection (Eq. 1) and related operations (Eq. 2). Take the seventh set of gray level plan (Level R7 and Level C7) as an example, the image stabilization results are shown in Figure 3 (by new method) and Figure 4 (by original method).
According to the eight gray bit plane, the calculated all of results are shown in Table 1. We can observe that their results and image stabilization effects are the same from Figure 3, 4 and Table 1.

Table 1. The calculated results are obtained through eight group images.

<table>
<thead>
<tr>
<th>Level</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>No level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral offset</td>
<td>-24</td>
<td>-1</td>
<td>11</td>
<td>6</td>
<td>0</td>
<td>55</td>
<td>56</td>
<td>56</td>
<td>56</td>
</tr>
<tr>
<td>Vertical offset</td>
<td>2</td>
<td>0</td>
<td>31</td>
<td>88</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

We found that the results levels 1-5 are unreasonable and the results levels 6-8 are reasonable. As we all know, the measurement results will be error, the simplest way to reduce the error is to take the average. Hence, it gets the relatively accurate offset and the offset $s = 55 + 56 + 56 + 56/4 = 55.75$. Although the two results of this calculation (55.75 and 56) cannot be reflected in the image stabilization difference (the minimum unit of the image is a pixel, it cannot be less than this unit when the motion compensation of the image is performed), this result is important if the result is applied to observation or measurement. This is also a meaningful work done in this study.

Another point to note is the scope of the level. After a lot of tests to prove that the level of reasonable results for different images is different (some are 6-8, some are 7,8), so it is recommended to use level7,8 in order to avoid unnecessary mistakes. Of course it does not rule out the use of a more extensive level (level 5-8 or 1-8, etc) under certain conditions.

Summary

There are many researches on the electronic image stabilization algorithm based on gray projection. However, it has not been proposed or studied from the gray level plane to consider the improvement of the algorithm’s accuracy. Based on this view, this paper launched a study of the relationship between grayscale plane and gray projection. It is found that the gray scale projection algorithm is used to calculate for each gray level plane and take the mean to reduce the error effectively. Experiments show that the method is effective.

Acknowledgement

This research was financially supported by the Harbin science and technology bureau innovation talent special funds (Youth reserve talent plan category) project. NO. 2016RAQXJ045.
References


