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Multicolor-Pattern Light Projection for 3D Image Matching

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Synopsis

In this paper, a new kind of pattern called Multicolor-pattern for image matching is proposed. The Multicolor-pattern possesses the advantage over conventional pattern in high-precision of 3D image matching abuse its wide matching extent and has great potential in the application areas of image processing. In this paper, we will describe the principle of Multicolor-pattern light projection and describe how to design the Multicolor-pattern and its application of image processing.

keywords: multicolor-pattern, structured light, light projection, opening width, point correspondence

1 Introduction

In recent years, image matching in the field of 3D image processing such as image recognition , recovery of the 3D image have attracted more and more interest. Up to now, various methods have been proposed in image matching, it can be generally divided into two categories, that is Contact-Matching and Non-contact Matching . Both of them consider about color, shape or scheme to resolve the problem of image matching. The Non-contact Matching is an initiative stereo method which take advantage of the principle of structured light. For this reason, the system for Non-contact Matching can be called light projection system. During the past years, various patterns such as Width Changed Pattern, Density Changed Pattern and Color Changed Pattern have been proposed. The Multicolor-pattern which proposed in this paper appears to be more effective in dealing with 3D image matching, owing to its advantage of wide matching extend and strong mapping capability. In Section 2, we will briefly review the light projection system. In Section 3, we will show how to design the Multicolor-pattern. The advantage of Multicolor-pattern is its wide matching extent.

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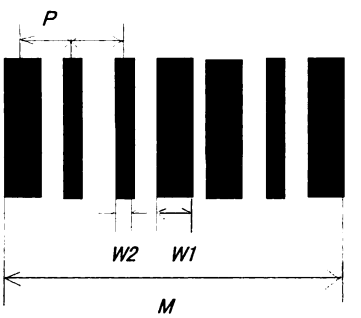
2 Light Projection

Various methods have been proposed in light projection such as Spot Light Projection, Slit Light Projection and Step Light Projection. But the method of Spot, Slit or Step all used simple light pattern to scan object space. To catch a 3D image, it requires to input image every a minute change of light pattern and detect a position of Spot, Slit or Step in every image. Therefore, to catch a high analysis and high-precision 3D image, a great deal of input are required. To resolve this problem, a method which called Encoded Pattern Light Projection in Space is suggested, fewer inputting images are required because of the encoded object space.

The Changed Opening Width Encoded Pattern is one of this kind of patterns as shown in **Fig.1**,



P- internal; *W*- opening width; *M*- pattern width

Fig.1 Changed Opening Width Encoded Pattern

As **Fig.1** shows, the Changed Opening Width Encoded Pattern has a characteristic of fixed slit internals and changed opening width. The more the changed opening width, the higher efficiency in encoded space is obtained, but on the other hands, the judgment becomes difficult and the possibility of misjudgment increases. To overcome this limit, a new pattern which called Multicolor-pattern is proposed here, it changes color not only changing opening width. Multicolor-Pattern provides more high-precision and wider pattern width than any other patterns.

3 Designing Multicolor-Pattern

In order to describe how to design the Multicolor-Pattern, some symbols and terms are defined as follows:

P------- internal

W------ opening width

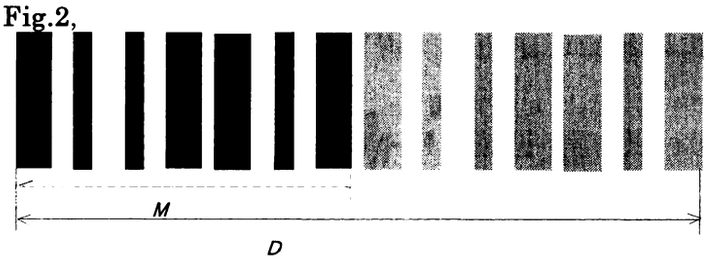
D------- pattern width

M------ block (a part of pattern)

N------ the number of colors

S------ the register memory for storing the fundamental Multicolor-Pattern

Making the Multicolor-Pattern is based on Changed Opening-Width Encoded Pattern. The case of two colors(Black and Gray), which are used to make the pattern, is shown in Fig.2,



M- length of block(a part of pattern); *D*- pattern width

Fig.2 a kind of Multicolor-Pattern

It can be easily seen that the pattern width can be expanded by 2 times. But is it possible to expand the pattern width more than 2 times in order to obtain wider pattern width? The answer is in affirmative, arranging the pattern like the way as shown in Fig.2, The pattern width have been expanded by 7 times, but whether or not the judgment is accurate enough to match image by such a wide pattern? For example, how can we make a distinction between parttern-line1 and pattern-line2 shown in Fig.3.

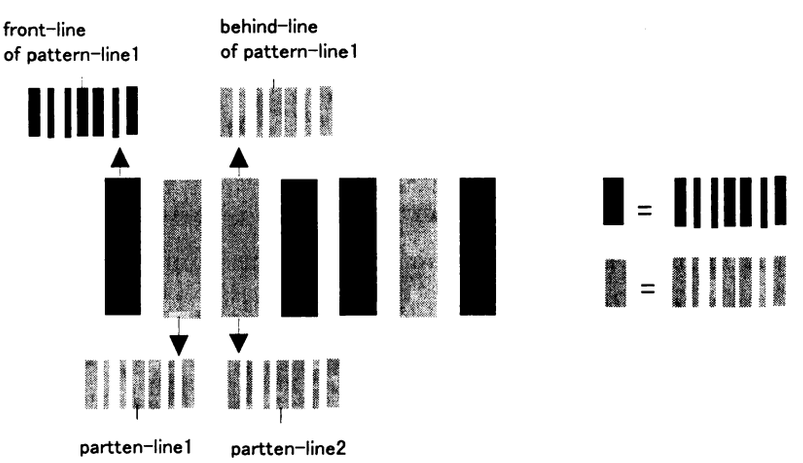


Fig.3 Multicolor-pattern using two colors

The processing is actually as follows: at first, the color of the front-line which is the length M in the front of the pattern-line1 is black can be judged, and secondly, the behind-line which is the length M behind of the pattern-line1 is gray also can be judged. Do as the same, the front-line of pattern-line2 is gray and the behind-line of pattern-line2 is black can be judged. Since the front-line and behind-line of every pattern line in different block are different, the correct judgment can be obtained.

To implement this method of judgment with the help of computer programming, the following steps are required. At first, storing the fundamental pattern in register memory S,

S = { (s[0][0],s[0][1],.....s[0][6]),
(s[1][0],s[1][1],.....s[1][6]),
.....
(s[6][0],s[6][1],.....s[6][6])}

and assume the matched pattern-line is X. then judge the matched line through the method proposed above, the program shown as follows,

```
Judge_pattern()
{
    VALUE1 = get_front_behind(S,X);     to get the color of front-line and
                                        behind-line of matched line
    B = judge_block(VALUE1);            to judge the matched line is in
                                        which block according to VALUE1
    L = judge_line(X);                  to judge the position of matched line
                                        in a block

    the result is the matched line X is corresponding the line to
    B-th block of L-th line.
}
```

The more colors are used, the wider pattern width can be obtained. Through a host of experiments, the formula for the relation between the number of colors and the pattern width is obtained as follows,

$$D = 7 \cdot P \cdot N! \qquad (3\text{-}1)$$

where N is the kinds of color , D is the pattern width and P is the internal. According to this formula, the corresponding table of the pattern width and the number of colors

is shown in Table.1,

Table.1

N	D
1	$7P$
2	$49P$
3	$98P$
⋮	⋮

It is easily proved that the number of colors become larger, the pattern width has expanded times by times accordingly. But the much more memory size is required, the quantity of judgment will be increased and the ability of colors' judgment becomes difficult. In practical use, considering the weakness of Multicolor-pattern , using two or three colors to design the multicolor-pattern is suggested and the chosen rule of colors is that the difference of colors' brightness is large enough to judge, it means that the colors which are easy to be confused is not suggested.

4 Conclusion

The Multicolor-pattern has wider pattern width than any other patterns. The design rule of it can be used to make fundamental patterns for various light projection system such as Spot, Slit, Step light projection and so on. The future study lies in improving the ability of judgment. Maybe adding shapes such as round, square and triangle to make pattern is a good idea.

References

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