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Research paper

Improvement of the KCF Tracking Algorithm through Object Detection

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Abstract

When the position of the beam projector is changed, users have to manually adjust the position. In this paper, we propose a system that can automatically correct images. In this process, the KCF (Kernelized Correlation Filter) algorithm is used for tracking the IR (Infrared) markers. We analyze the object tracking failure problem of the KCF and improve the KCF tracking algorithm that solves the problem through object detection.

Keywords:Detection, Tracking, KCF algorithm, Color space, Histogram.

1. Introduction

When displaying images with a beam projector, it is not always set to the fixed position. So, the position of the image is twisted. In order to correct the position of images, we use the algorithm which calculate the amount of conversion of the marker coordinate to automatically correct the image.

We track and detect IR (Infrared) markers with the IR camera placed in the embedded system. The device we used is composed of an IR camera and IR LED. If the IR LED emits IR light, the marker reflects light, then we can capture the reflection of the light and predict the position of the markers. [1]

Object tracking algorithms include TLD (Tracking Learning Detection), GOTURN (Generic Object Tracking Using Regression Networks) and KCF (Kernelized Correlation Filter). TLD learns object features, while tracking and detecting object [2]. GOTURN is a tracking algorithm based on CNN (Convolutional Neural Network) and shows high tracking speed [3][4]. KCF tracks the object based on Kernel based tracking, it has a high processing speed and is superior for tracking the object in real time [1][5][6]. KCF algorithm shows good performance in the embedded environment without high computing power compare to other algorithms. So, in this paper, we adopt KCF algorithm and propose the algorithm that compensates the defect of KCF.

2. Improved KCF Algorithm

2.1 KCF Problem

KCF has a high tracking rate, if there is no obstacle between the camera and the region of interest. However, if the obstacle covers the target area as shown in figure 1, it loses the object, and tracking erroneous area.

Figure 1:.Erroneous KCF tracking results

The reason for this problem is that KCF's response map deletes other areas except for the tracking area and constructs the map. KCF set candidates of objects to be tracked in the map and predicts the object. If obstacles cover the map, candidate objects are changed and tracking other objects.

2.2. KCF Improvement

To compensate the defect of KCF, we redefine the object detection layer, and added to KCF. We propose the method depicted in Figure 2, which can overcome tracking failure due to the obstacles, when tracking object via redetection.

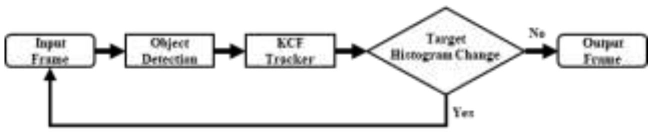

Figure 2:. Flow of detection and tracking

The algorithm we presented has relatively fewer features, because color space and histogram are the main methods. Therefore, we used an IR indicator that can be classified only through color difference and brightness.

2.2.1. Feature Extraction and Histogram Values

IR marker has no distinct features compared to other objects. However, we can classify the markers into chrominance, luminance and brightness which are main features of IR. Therefore, we implement YCrCb, Luv and Lab which can convert RGB into gray scale based on main feature points of IR. And we make one frame by using ‘and operation’ to clearly extract the features of marker.

The histogram is a graph showing values of hue and brightness of the image, and each image has intrinsic range of histogram values. The histogram of the tracking area maintains certain range of values. However, if the obstacle blocks the area or if the tracking label moves another position quickly, the histogram values will be changed. So, we canfind out the tracking failures by using change value in the histogram.

3. Implementation and Testing

We converted the frame into three color spaces via marker's RGB values and lightness features, and then made binaries frames. Looking at Figure 3, the frames in the color space show different results, but the combined frame only shows marker.

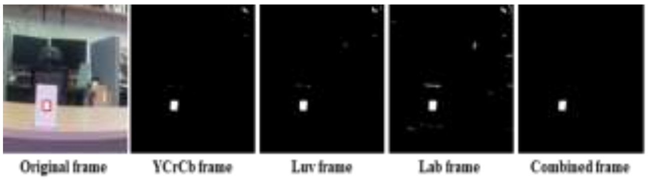

Figure 3:. Test results of color space frames

The histogram of the area tracked by KCF is the same as Figure 4 (a). However, when the obstacle covers the marker, we can see that the histogram is transformed like Figure 4 (b). Using the variance in histogram of these trace areas, the tracking failure was determined.

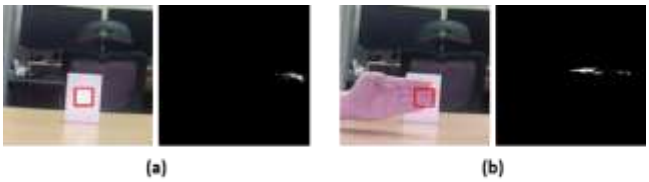

Figure 4:. Histogram results of target area and blocked area

When the tracking failure is determined, the detection algorithm redetects the marker and resets the KCF's trace area. As shown in Figure 5, it can be confirmed that the marker is tracked again after shielding phenomenon.

Figure 5:. Tracking and redetection results

In this way, the redetection was performed by using the detection algorithm as shown in Figure 5, the FPS (Frames Per Second) of the KCF has an average of 46.1 and the FPS of the KCF which the redetection algorithm is applied has an average at 46.0, there is no difference from FPS of original KCF. As a result, we applied detection algorithm to the KCF, but confirmed that the real time is guaranteed without affecting tracking and video speed.

4. Conclusion

In this paper, we have identified the cause of failure of KCF tracking and proposed the detection algorithm to extract special features of IR markers by using color difference, luminance and brightness. And we implement this algorithm, which is executed depend on tracking area’s histogram value change amount in order to deal with this problem.
As a result of using this system, the performance is similar in terms of FPS compared to original KCF. Failures of tracking are evaluated to track the markers through redetection. However, when the illumination is changed, the features of marker are affected by visible light, decreasing detection accuracy. Therefore, additional research on detection algorithm which is not affected by illumination is necessary in the future.

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