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Processing of Image captured by Omnidirectional Camera for Object Detection

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Abstract: In this paper, we introduce a method for processing of image captured by omnidirectional camera before object detection task in the image. The processing is necessary due to a limitation of image input for detection system. Here we use YOLO v.8 to detect objects in the image. So far we know YOLO successfully detect some objects in an image in panoramic view. However for hemisphere view, such as image captured by omnidirectional camera, YOLO fail to detect objects in it. Our experiment successfully convert hemisphere view into panoramic view, then YOLO successfully detect some objects in it.

Keywords: omnidirectional camera; YOLO; hemisphere view; panoramic view; object detection

1. INTRODUCTION

Nowadays object detection based on computer vision has been done in many area. One of cameras used is an omnidirectional camera. The advantage of using this camera is it can capture a 360 degrees view of the surrounding scene, so that it has fewer blind spots [1],[4],[5].

The usage of omnidirectional camera are in drone [1], in robotic [2],[3],[6].

The hemisphere view is image captured by omnidirectional camera. The hemisphere view is 360 degrees view by a camera.

YOLO frames the detection process as a single-stage regression problem, which simultaneously predicts bounding box and class probabilities. The YOLO method can detect objects very quickly. However, there are still some localization errors, and relatively low accuracy when compared to methods based on the proposed region [7],[8],[9],[11],[12]. Since then, several additional improvements have been made, with the proposed YOLOv2 [10]. Anchor boxes are added with a resolution of 416x416 and use darknet-19 which has 19 convolutional layers and 5 pooling layers as feature extraction. YOLOv2 evaluated on the PASCAL VOC 2007 dataset [10] obtained a Mean Average Precision (mAP) of 78.6%, with 40 FPS faster and more accurate when compared to Faster R-CNN with VGG16 which have a result 73.2% mAP with a detection speed of 7 Frame Per Second (FPS), and also more accurate than YOLOv1[9].

YOLO fail to detect some objects in an input image in hemisphere view. This problem can be solved by converted the hemisphere view into panoramic view. The hemisphere view captured by an omnidirectional camera as in Figure 1.

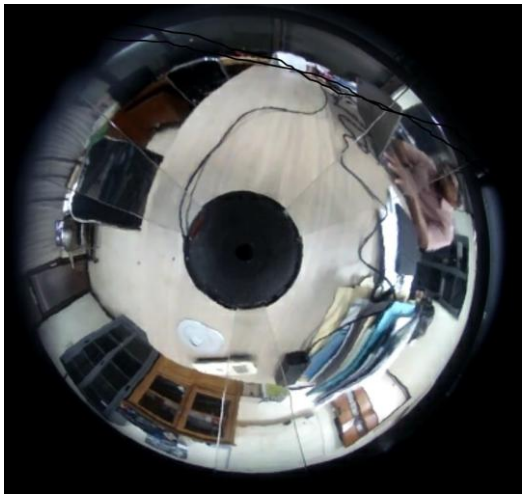

Figure. 1 The hemisphere view captured by an omnidirectional camera

2. THE PROPOSED METHOD

In this section we will explain briefly our proposed method of preprocessing task, i.e. conversion the hemisphere view into panoramic view, and the boundary adjustment.

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2.1 Conversion the hemisphere view into the panoramic view

In this section we will explain briefly the conversion of the hemisphere view into the panoramic view. The basic equation is a circle equation as in (1)

$$(x-x_c)^2 + (y-y_c)^2 = r^2 \quad (1)$$

where (x,y) is a coordinate in 2D, (x_c,y_c) is coordinate of circle's center and r is a circle's radius. In an image of hemisphere view, x can be represented as column and y as row, in a certain r. Figure 2 shows the relation between coordinate (x,y) and (c_p,r_p)

In panoramic view, we define r_p is row coordinate, c_p is column coordinate, i.e. the length of $(x_c,y_c\text{-}r)$ to (x,y), then

$$r_p = y_c - r \quad (2)$$

$$c_p = \theta.\pi.r/180 \quad (3)$$

where $\theta = \sin^{-1} x/r = \cos^{-1} y/r$.

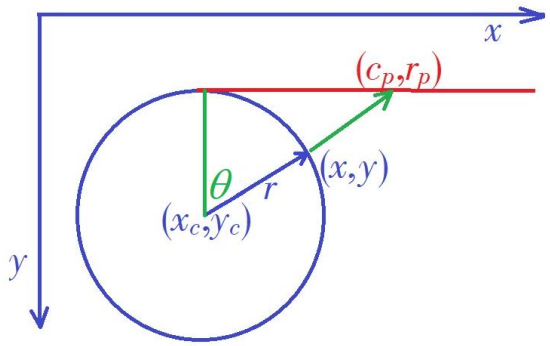

Figure. 2 The relation between coordinate (x,y) and (c_p,r_p)

2.2 The boundary adjustment

After conversion the hemisphere view into panoramic view, the image result need to adjust at right and left side, due to the number of pixels at the upper side are different from at lower side. There are more pixels at the upper side than the lower side. This due to the outside circumference is longer than the inside circumference.

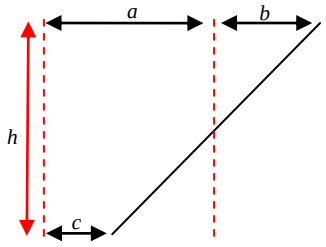

Figure. 3 The boundary of pixels at right side

Figure 3 shows the boundary of pixels at right side from the center. In Figure 3, the number of pixels at upper side are $a + b$, the number of pixels at lower side are c and h is the height of image. Then,

$$maxP = a + b \quad (4)$$

$$minP = c \quad (5)$$

the slant of pixels at the right side, m, is

$$m = (maxP - minP)/h \quad (6)$$

then the updating of pixel's coordinate is

$$x(\text{new}) = x(\text{old}) - (maxP - minP)/2 + m.y \quad (7)$$

where x is image column, y is image row.

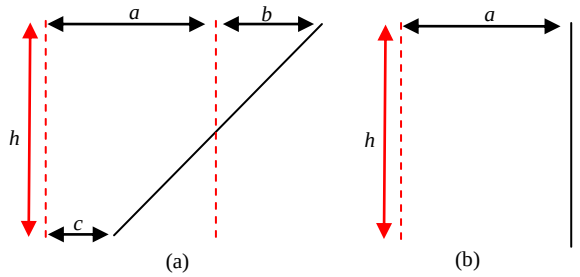

Figure. 4 The pixels adjustment process (a) before adjustment (b) after adjustment

3. THE EXPERIMENTAL RESULT

In this section, we explain our experimental result. As in Figure 1 as input image, the conversion result is depicted in Figure 5. In Figure 5, we successfully convert the hemisphere view into panoramic view. At the upper side, more pixels than the lower side, due to the outside circumference of hemisphere view longer than the inside circumference.

The boundary adjustment result is depicted in figure 6. In Figure 6, pixels correction are done in right and left side. If the objects are seemed slant in edge side in Figure 5, in Figure 6, they have seemed straight.

Figure 7 is the detection result by YOLO v.8.

4. CONCLUSION

In this paper, we demonstrate preprocessing process before object detection task by using YOLO v.8. The preprocessing process are conversion the hemisphere view into panoramic view, then the boundary adjustment.

We successfully accomplish two tasks, then YOLO successfully detect some objects in it.

The future work need to improve the boundary adjustment, so that pixels change are smoother.

5. ACKNOWLEDGMENTS

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Figure. 5 The panoramic view result before image augmentation

Figure. 6 The panoramic view result after boundary adjustment

Figure. 7 Object detection result by using YOLO v.8