Real-Time Head Detection with Kinect for Driving Fatigue Detection

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Introduction

Nowadays, depth cameras such Microsoft Kinect make it easier and cheaper for us to capture depth images, so it becomes practical to use depth images for detection in consumer-grade products. We propose a novel and simple real-time method to detect human head in depth image for our driving fatigue detection system, based on the elliptical shape of human head.

Work-flow and Key Steps

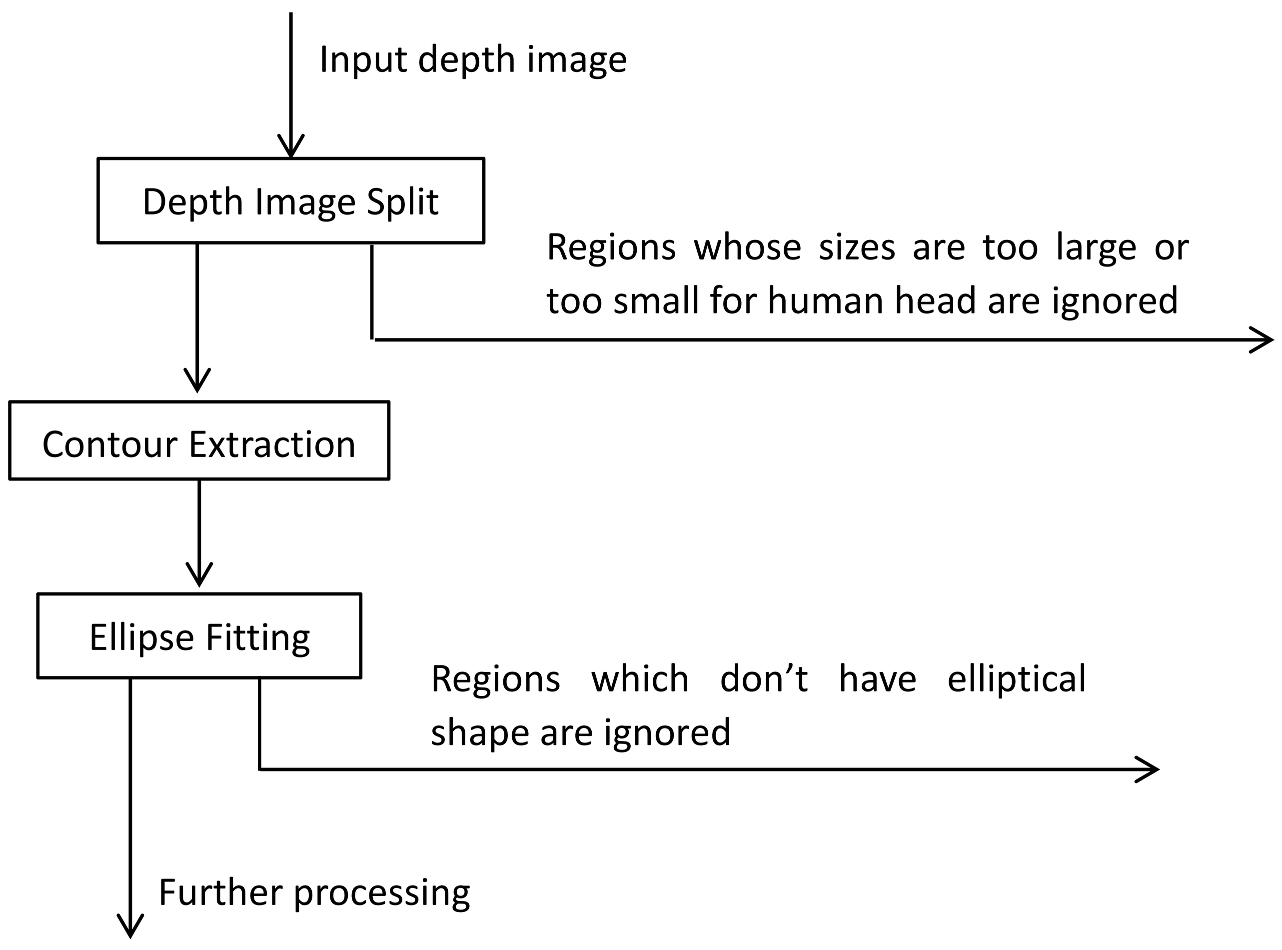

Figure 1: The work-flow of our head detection method.

Depth Image Split

Image split is a kind of image segmentation. Considering effectiveness, simplicity and speed, we choose image split based on computing connected components which is enough for our method. Fig. 2 is an example of image split. Here different regions are colored with different colors. We can see that the region of head has been split out.

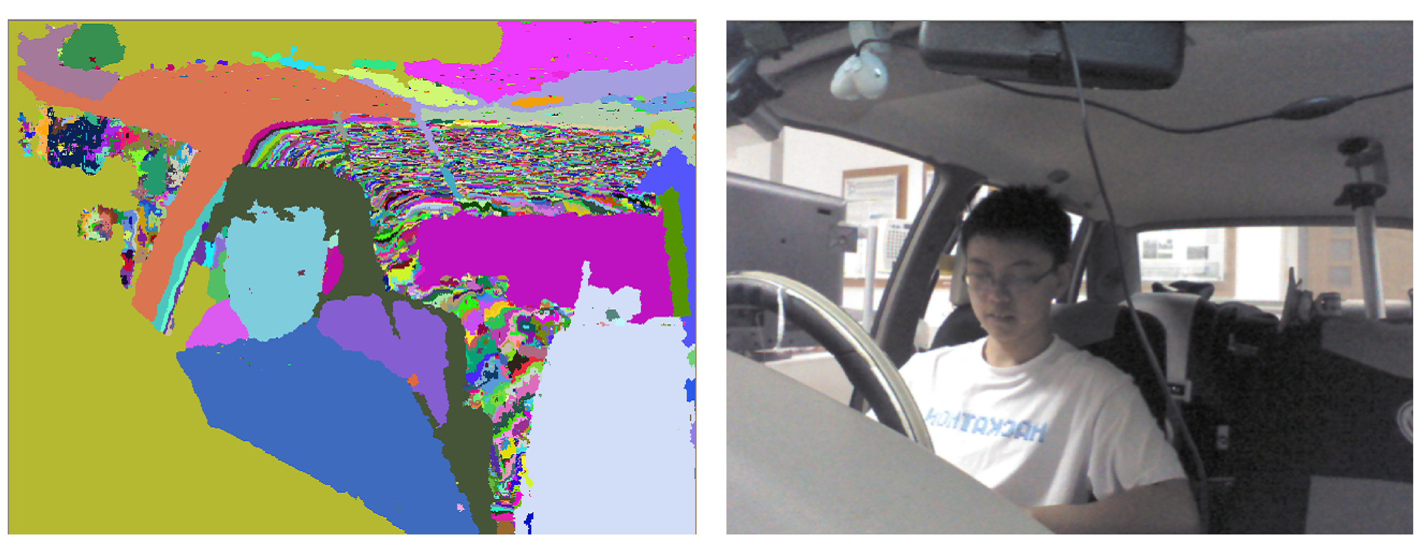

Figure 2: An example of image split result. Corresponding color image is for reference.

Contour Extraction

After the depth image is split into different regions, contour extraction is performed. Contours are expressed by contour points. Fig. 3 gives an example of a region and it's corresponding contour points. One pixel in depth image is represented by one block.

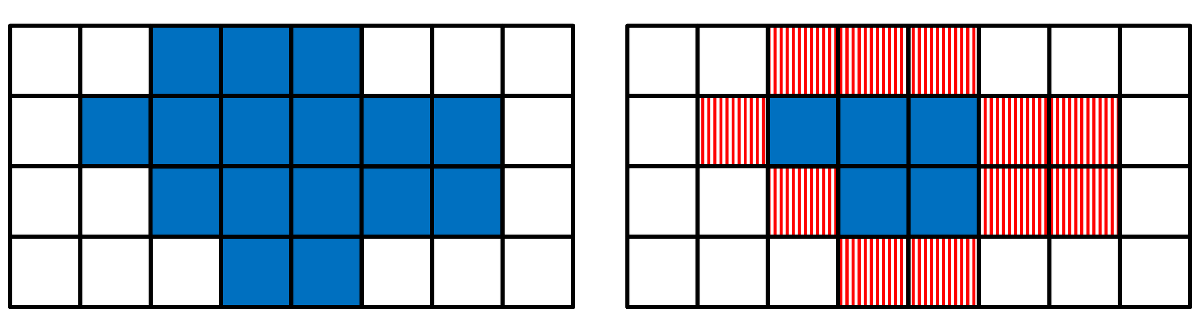

Figure 3: A region in depth image and it's corresponding contour points.

We use an contour extraction algorithm which 'walks' along the boundary of each region.

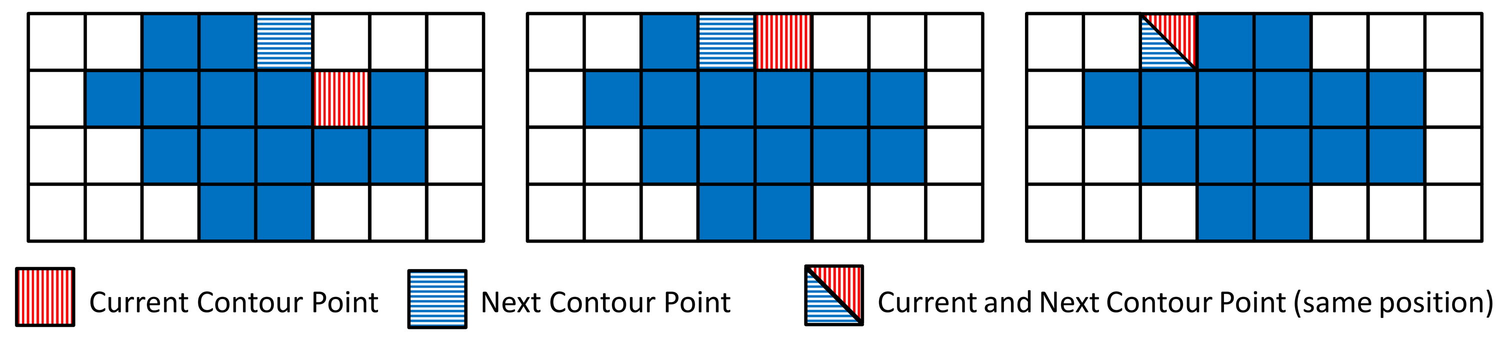

Figure 4: A region in depth image and it's corresponding contour points.

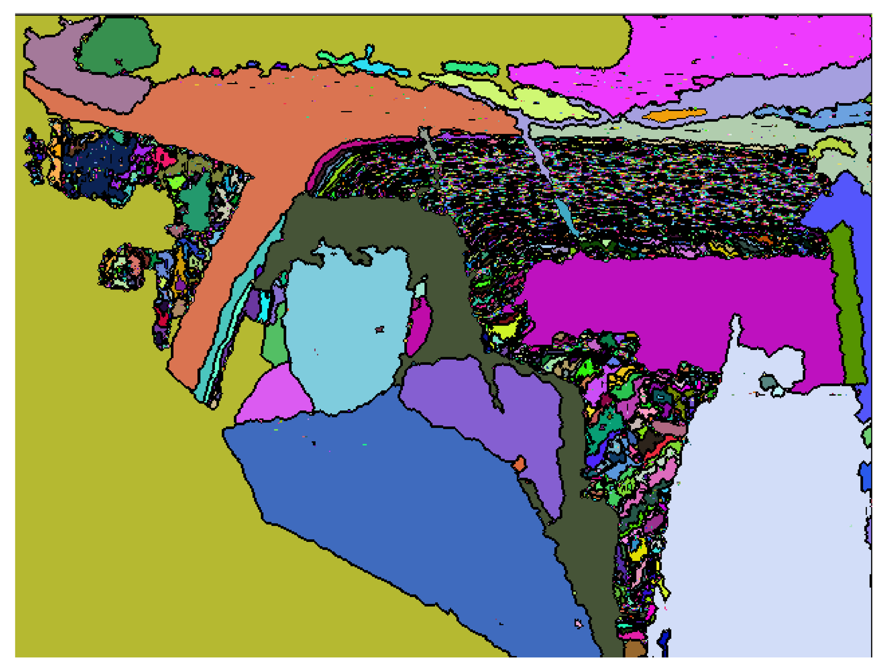

Figure 5: A region in depth image and it's corresponding contour points.

Ellipse Fitting

Having found the contour of each region, we can use any ellipse fitting algorithm to fit an ellipse for the contour points. We calculate fitness for each region using the formula below (less fitness value means higher fitness degree):

$$\frac{\sum_{i=1}^{n}\delta_i}{n\cdot h} \qquad (1)$$

In conclusion, we calculate the normalized average offset of every contour points.

After we get the fitness of each region. We return the region whose fitness is less than a certain threshold as the human head we detected.

Integrate with Driving Fatigue Detection System

Fig. 6 shows the work-flow of our driving fatigue detection system. Here, head detection in depth image is an important step which speeds up the whole system.

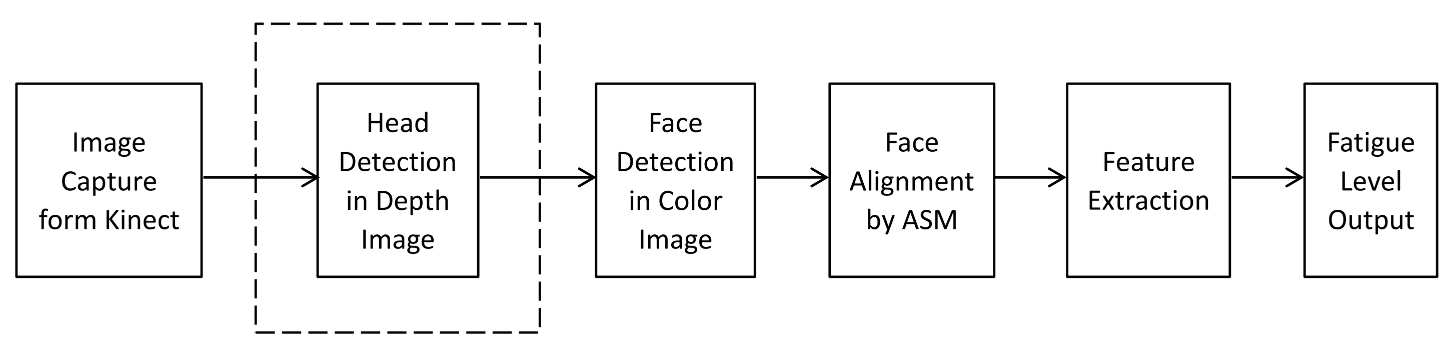

Figure 6: A region in depth image and it's corresponding contour points.

Conclusion

We proposed a novel human head detection method for depth image, which is both simple and robust. The validity of the method is demonstrated by integrating the head detection method into our driving fatigue detection system. In the future, we plan to improve our method so that it can deal with very bushy hair and beard. For the driving fatigue detection system, we will add more features to get more accurate result.