# 20th LSI Design Contests

# in Okinawa Design Specification

# 1. Purpose

Include the human detection as one of image recognition technology. Human detection is a technique used in the digital camera, the automobile automatic brake system and monitoring system.   
Therefore, this exercise is aimed at performing a hardware design of the operation unit as a theme of "human detection by Histogram of Oriented Gradients", conscious operations and cost calculation algorithm. The challenge of Level1, design the arithmetic unit of human detection by Histogram of Oriented Gradients. The challenge Level2, all of the input format is not restricted. Please aim to design a more unique computing unit.

# 2．Design enviroment

MATLAB, Synopsys Synphony

Synopsys® Synphony Model™ Compiler

Synopsys® Synplify Pro®

Synopsys® Design Compiler®

Mathworks® MATLAB® /Simulink®

These environments will be listed in our response to the design environment.

Synplify Pro/Premier or other logic synthesis tool

RTL handcoding( VHDL or Verilog-HDL)

# 3. Development Environment

In recent years, studies have been actively carried out for the human detection from an image, a number of approaches have been proposed. I explain about human detection by Histogram of Oriented Gradients.

## 3-1. HOG

Histogram of Oriented Gradients (HOG) is a feature descriptor used in computer vision and image processing for the purpose of object detection. We can get quantity of strong characteristic from the shape change of the object by dividing a local domain into plural blocks, and making the incline of each the histogram.

Fig 1：A flow until becoming histogram

・The following (1) - (5) is the process to get quantity of HOG.

(1) Resize an image to pixel size and read it in gray scale.

(2) Calculate gradient magnitude and gradient angle from the brightness of each pixel.

We calculated gradient magnitude and the gradient angle by the following expressions.

Gradient magnitude：

Gradient angle：

(3) Calculate the histogram of gradient in each cell.

We quantized gradient angle each 20 degrees from zero degree to 180 degrees in 9 directions and calculate histogram in each cell domain.

Fig 2：Histogram of 9 directions

(4) Normalize each block.

We normalized each block by the following expressions.

v(n) is gradient angle histogram. q is cell size. N is the number of gradient angle. In addition, the denominator is a grand total of the quantity of HOG characteristic included in 1 block (q X q cell). For one cell, We normalize multiple times.

(5) Integrate all histogram.

## 3-2. SVM

Support Vector Machine (SVM) is one of the pattern identification technique and is used for image recognition and speech recognition. We used linear SVM．

Let learn learning data of INRIA Person Dataset, and chooses hyperplane becoming margin maximum in hyperplane dividing into the data of the 2 level class. As a free library of linear SVM, We used LIBLINEAR.

The classifier of person or not person by 2 classes is shown in Fig 3．

Fig 3：Figure of identification by the 2 classes classification

## 3-3. Algorithm

The algorithm of the person detection using Histogram of Oriented Gradient based on the program that was designed in MATLAB® is shown below.   
　In addition, it was created and verified using MATLAB®R2012a (7.14.0.739).

* zip file：[En\_human\_detection.zip](http://www.lsi-contest.com/spec/En_human_detection.zip)

Image and m-file, mat-file are included in a zip file. Simulation of human detection is carried out when carry out 'humanDetector\_16\_09\_13.m' which is this main m-file.

(1)Input image  
Input the RGB image.  
  
(2)Grayscaling and binarization  
Since the detection process using a color image is difficult, the input image is converted into grayscale image. We use the NTSC Coef. method to grayscale of the image. The NTSC Coef. Method, in one method of converting from a color image to 256-level grayscale image, it can be calculated by the following equation.

Y=0.298912\*R+0.586611\*G+0.114478\*B

Coefficients of this equation are obtained from the human visual characteristics experimentally for the color.   
  
  
(3)Detection process  
(3-1) Resize grayscale input image at different scales In our algorithm, the detection process uses an image window of fixed-size (128 x 64 pixels) to scan over the whole input image, and the size of the human body in each image varies at different scale. Therefore, algorithm needs to sequentially resize the original-size input image into images with smaller sizes (as long as the image window can be included in the resized input image).  
  
(3-2) With each resized input image:

+ Scan the image window (of 128 x 64 pixels) over the image

+ At each position of scanning, compute the Histogram of Oriented Gradient (HOG) descriptor [1] for the image window.

+ Determine the image window to have human body or not, using the trained linear Support Vector Machine (SVM) classifier.

+ If the image window include a human body inside, save its position in the resized image (i.e. coordinates and the scaleused) and detecting score for the next step.

(4)Fusion of multiple detects  
At each resized input image, there can be more than one detect around each unique human body. In other words, it is possible to have many overlapping detects over each human body in the input image. The final target is to fusing these overlapping detects so that there is only one detect for each human body.

(5)Output  
Draw bounding boxes around true human bodies (if any) in the input image.

## Reference

[1] 機械知覚&ロボティクス研究グループ，中部大学 “局所特徴量と統計学習手法による物体検出”  
　　　 http://www.slideshare.net/MPRG\_Chubu\_University/ss-32258845

[2] 藤井 龍也，中島 克人，野口 祥宏，西田 健次，" HOG と SVM による上半身検出器の特徴の抽出位置に関する考察"， FIT2011（第10回情報科学技術フォーラム)，pp.105-106，2011．

http://ci.nii.ac.jp/els/110009622743.pdf?id=ART0010089832&type=pdf&lang=jp&host=cinii&order\_no=&ppv\_type=0&lang\_sw=&no=1473992065&cp=

[3] INRIA Person Dataset，

http://pascal.inrialpes.fr/data/human/

[4] LIBLINEAR -- A Library for Large Linear Classification，

http://www.csie.ntu.edu.tw/~cjlin/liblinear/

The flowchart of the algorithm is shown in Fig 4．

Fig 4：Flowchart of template matching