The Hardware Solution of a New Image Processing Algorithm

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ABSTRACT

This paper presents a new image-based parking space detection algorithm, the algorithm is based on a joint decision on multi-feature image processing algorithms, according to the data threshold of variance, correlation and edge-point density joint adjudicate the seize of paring space, it has a high recognition rate. And then the authors transplanted this algorithm into the FPGA platform, the hardware solution are implemented. And according to the algorithm characteristics the authors improved and optimized it. And the final, a compared test between hardware and software algorithms was executed, which results show that, the hardware algorithm for the solution is not only maintain a high recognition rate, but also more efficient.

Keywords: FPGA, Hardware Algorithm, Image Processing, Image-Based Parking, Parking Detection

1. INTRODUCTION

Image processing algorithms because of its large amount of data calculation, it will take more resources, and the calculation speed is usually slower. To optimize the image processing algorithms, without changing the original function of the algorithm, improve operational efficiency and consume less resource has become a necessary step in image processing algorithm design (Tsinghua University, 2007). This paper proposes a parking space detection image processing algorithms and introduces the implementations of the algorithm that transplanted to FPGA platform by hardware solutions.

2. PARKING SPACES DETECTION ALGORITHM

To analysis the Parking on-site images, we concluded that the image has these characteristics: vehicle has various size and shapes, spaces themselves can be disturbed by many environmental factors (such as sunlight intensity, rain and snow, shadows, surface water stains, etc.), restrictions on camera placement and other reasons such as the block between spaces. In response to these characteristics, we propose a mathematical based on the image, edge and
other characteristics identification method to detect each individual parking space (Tsai, Hsieh, & Fan, 2005).

In order to obtain a higher recognition rate, we propose three parameters, namely variance, correlation and edge point density (Deng, Jiang, & Wei, 2006). These three parameters are the exemplification of mathematical, image and edge characteristics, in order to reflect the parking spaces between cars and no car. The specific detection of the following steps.

2.1. Step 1

Select a background image with the requirements: less interference, no apparent obstacles, water stains, no obvious shadow coverage, read the image and convert it into grayscale.

2.2. Step 2

Set the border coordinates of the image to test, the purpose is to intercept the information contains only the image of parking spaces under test. The implementation are as following: we get the resolution of the YUV image 720 × 576, including six parking spaces, one of them will as a test. This test car parking space is the part of interested in the whole image, our aim is to retain the original scope of the test information on car parking space, and set other parts of the pixels to zero, we can draw a four polygon edges of parking spaces, retain the four edges surrounded Polygon area information, and set other parts to zero, and then delete all zero rows and columns, and finally obtain the smallest rectangle containing the polygon spaces, which is the image we want to deal with; parking information Image shown in Figure 1.

2.3. Step 3

To obtain the background of parking spaces that be tested, cut the background image frame that selected using the same method in step 2, save the value of the background image into the background image pixel array.

2.4. Step 4

For each tested image frame, calculate as following operations:

- Read each under test image frame, convert it to grayscale;
- By using the method of Step 2 to cut the border coordinates of the tested image, the rectangular image pixel values will be stored in the under test array, and subtract the array with the background array that obtained in step 3, evaluate the absolute value, and then calculate the variance.

The calculation steps are as shown in Equations 1 and 2. The variable PGroi and PGbg are under test image pixel values and background image pixel values;

\[
subPG = abs(PG_{roi}[i] - PG_{bg}[i])
\]  

\[
D = \sum (subPG[i] - subPG)^2
\]
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