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Theoretical Implementation of Near and Far Spread Images of Omnidirectional Camera

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Abstract

Traditional surveillance system sent images from network camera to the management server and saved the images in a hard disk. These surveillance systems might have some problems when they are used for a large space like a parking lot. These problems are a lot of network cameras, wide traffic bandwidth and a large amount of disk spaces. This paper proposed the system by compression and decompression method using omnidirectional camera. The decompressor produces spread images of the near and far slice from the circular shaped original images which are stored at every one second by the compressor. In case of open-roof places it produces reversal images for right view. As an implementation and test, the proposed system shows a lot of efficiencies in number of cameras and disk spaces.

Keywords: *Omnidirectional Camera,Spread Images, OpenCV*

1. Introduction

Traditional surveillance system sent images from network camera to the management server and saved the images in hard disk. Sometimes it has used motion capturing techniques for reducing spaces of hard disk. These surveillance systems might have some problems when they are used for a large space like a parking lot. First of all, for that every car is in surveillance, there must be a lot of network cameras which are necessarily requiring of install cost. As well, it needs enough traffic bandwidth for these cameras. Furthermore it requires a large amount of disk space. These problems are encountered by a developer of surveillance systems. Therefore, fundamental solution of these problems is to use both compression and decompression. The compression means that several cameras and network traffics and storage get into smaller. And the decompression means expanded images from the compressed basic images stored. This paper proposed the system for this fundamental solution by omnidirectional camera. This system uses basically the meaning of compression. So the resolution of the original basic image is very important. Two factors affect this resolution issue except for the resolution of camera obviously. One is the protocol to transfer data. And the other is the coding of video compression. These days many systems adopt the RTMP transfer protocol and H.264 coding. RTMP protocol is Real Time Messaging Protocol for streaming video and audio by Adobe corporation which is mostly used by Adobe Flash. It uses port 1935 basically, but alternately uses port 443 or port 80 when to fail to connect. RTMP frame structure is shown below. H.264 is a standard for video compression, As well, it is currently one of the most commonly used formats for the recording, compression, and distribution of high definition video.

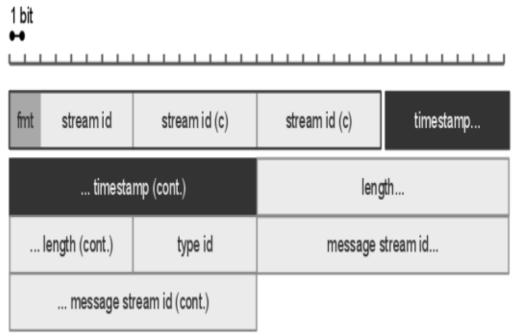

Figure 1. Header structure of RTMP

2. Proposed System

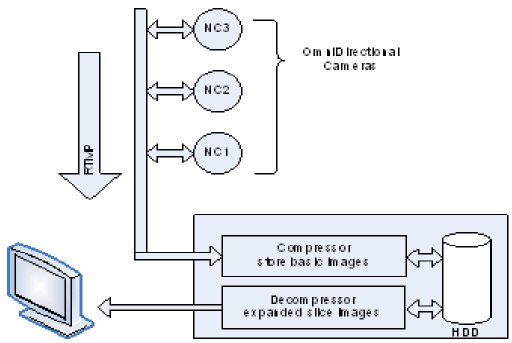

Figure 2. The structure of the proposed system

The above figure shows the structure of the proposed system. It is not so complicated. The suggested system needs to decompress the stored basic image. This procedure makes 16 slice images. 360 degree is sliced by 45 degree each. So it produces 8 slice images. There are two kinds of images as near and far. Therefore the total slices are 16.

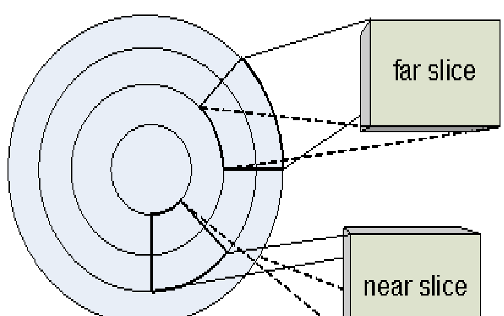

Figure 3. Spread images of far and near slice

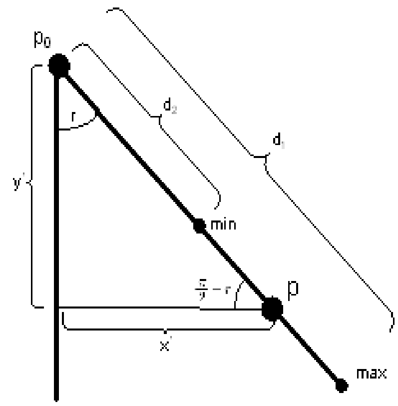

Figure 4. Principal concept of spread images

Figure 4 illustrates the expanded image transformation. The omnidirectional camera takes a image of circular shape. Therefore, expanded image must be tansformed by a polar coordination.p0 is the center point of original circular image. Each expanded slice image is consisted from min point to max point. The certain point p has displacements of x' and y' from p0. You can get the displacements by those equations below.

$$d = |p_0 - p| \tag{1}$$

d is the distance from p0 to p, and has the range from d2 to d1. So the gamma is the factor of rate. and then d is described by gamma.

$$d = d_2 + \lambda \times (d_1 - d_2) \tag{2}$$

the displacements x' and y' are computed by d and r.

$$\begin{cases} x' = d \times cos\left(\frac{\pi}{2} - r\right) \\ y' = d \times \cos(\frac{\pi}{2} - r) \end{cases} \tag{3}$$

In the cartesian coordinate system, point p is calculated by the center point p_0.

$$\begin{cases} p.x = p_0.x + x' \\ p.y = p_0.y + y' \end{cases} \tag{4}$$

Flowchart below shows how to produce slice images. It uses opencv library and includes two header files (core.hpp, highgui.hpp). The application is builded by visual studio 2010.

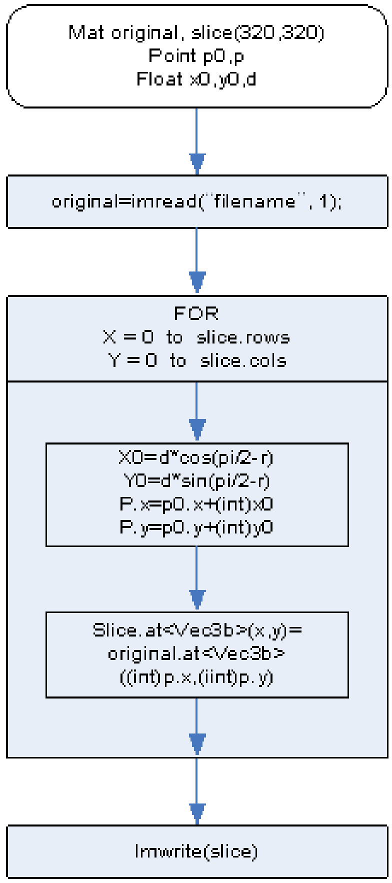

Figure 5. Image spread procedure

3. Example of Parking Lot

The proposed system is tested at the parking lot which is located in an office building. Because of difficulties that the omnidirectional camera is installed on the ceiling, people endeavered to hold it up. The right side shows the region of the parking lot.

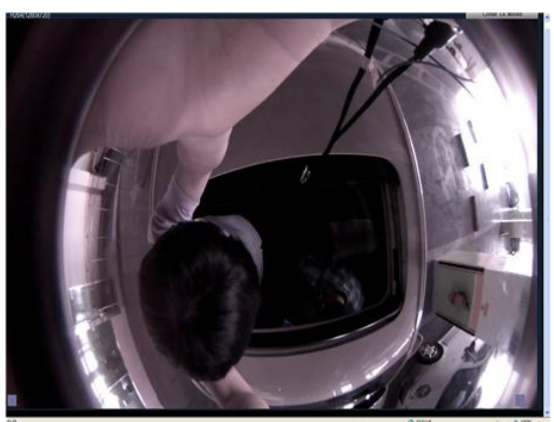

Figure 6. Original image of camera at a parking lot

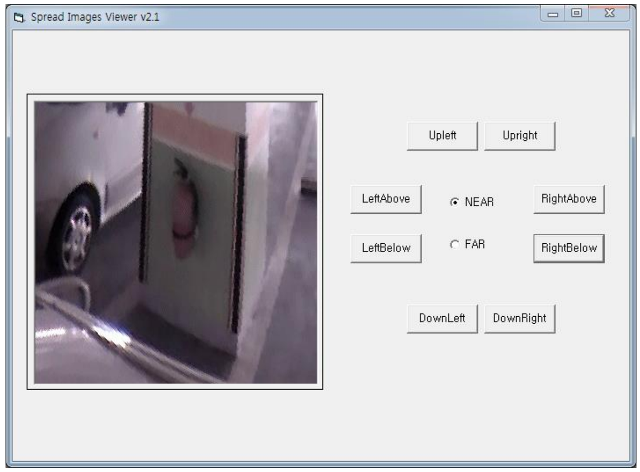

Figure 7. Spread image of near right below slice

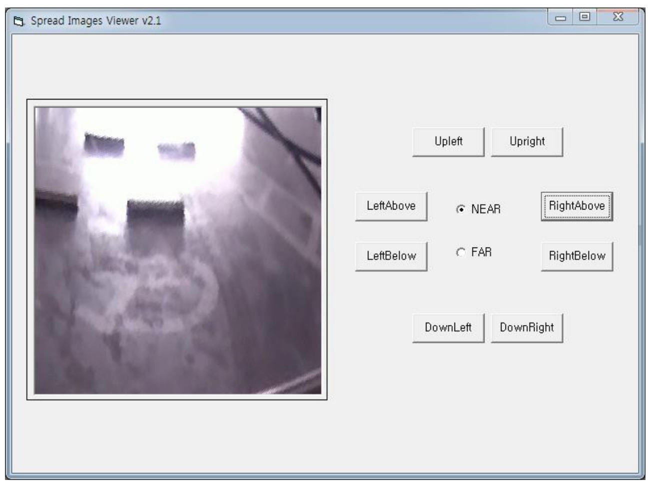

Figure 8. Spread image of near right above slice

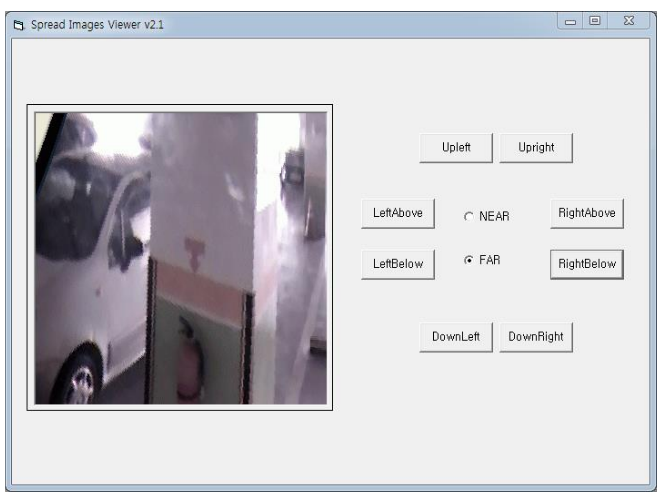

Figure 9. Spread image of far right below slice

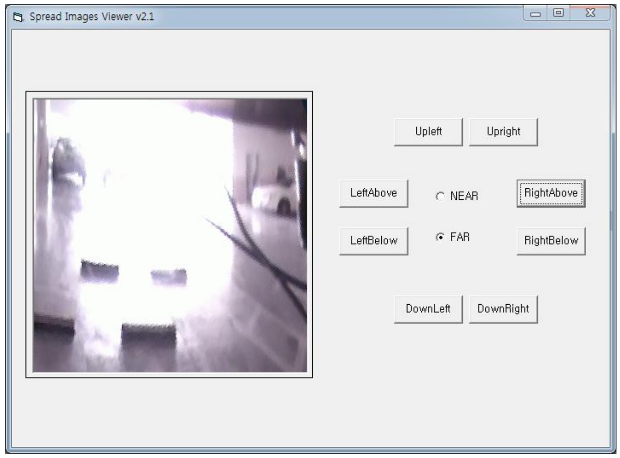

Figure 10. Spread image of far right above slice

4. Alternative Method of Ground Camera

The omnidirectional camera is a half sphere shape. The flat circle part tends to attach a ceiling. But sometimes the camera can be the opposite position. For an example there is no roof like a open stadium. In that case the spread images should be adjusted for right view. And consequently the spread images can be calculated by a little bit different way. A figure below shows the two-dimensional loops of ceiling-attached camera.The loop variables in a spread image are row and column, and the original variables in a slice image correspond to r and d respectively. The variable d is calculated by d1, d2 and rate factor shown by equation (5).

$$d = \mathrm{d}_2 + \mathrm{rate} \times (\mathrm{d}_1 - \mathrm{d}_2) \quad (5)$$

The only difference of the camera on the ground is the direction of an inner loop for row variable. So the variable d is calculated from far point to near shown by equation (6)

$$d = \mathrm{d}_1 - \mathrm{rate} \times (\mathrm{d}_1 - \mathrm{d}_2) \quad (6)$$

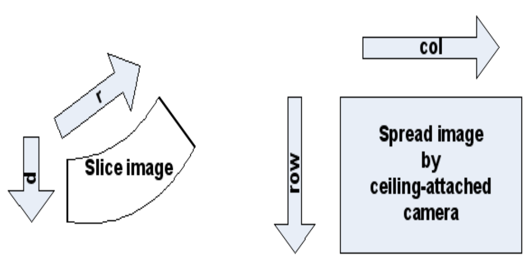

Figure 11. Directions of loop variables by ceiling-attached camera

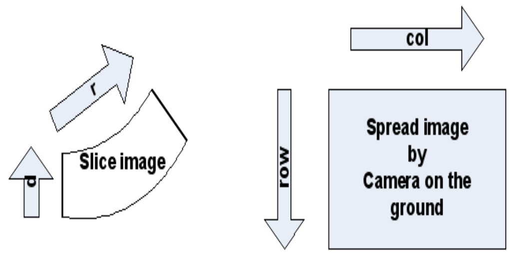

Figure 12. Directions of loop variables by the camera on ground

5. Conclusion

The proposed system is to use the omnidirectional camera and to display spread images instantly by stored circular shape images. This system reduces the number of cameras and also decreases the traffic from the camera to the management server. Even more it shortens the disk space by saving circular shape original images. The system can produce spread images by polar transformation rapidly. Therefore no extra storage need to save spread images every second. When you want to observe a scene, you could just get the expanded slice image by transformation. This system has good performance because of these reasons. But the resolution may become lower at the slice images. As a result, it could produce the slice image of 320 by 320. This resolution is enough to discriminate the queer passers near the car.If you want higher resolution, you could get it by increasing the resolution of the original omnidirectional camera.

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