DEVELOPMENT OF DIGITAL VIDEO CAMERA AND APPLICATION FOR HUMAN MOTION ANALYSIS

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ABSTRACT

The change in photogrammetry from analog to digital means a change from film to CCD sensor and real-time imaging became possible. It can be said that the most remarkable point of this change in photogrammetry is acceleration of real-time imaging. There are many kinds of digital still cameras on the market and these have became useful instruments in real-time imaging for stationary objects.

For moving objects, a video camera is utilized since 30 or 60 frames are acquired per second. Especially, video image sequences often give important information about dynamics of human motion in the field of sports training or rehabilitation. A video camera means 8 mm camera; however, an 8 mm camera is an analog camera in spite of the fact that a CCD sensor is used and an analog image cause a bottleneck for real-time human motion analysis. Thus, development of a digital camera is expected and the change in video camera from analog to digital means a change from analog tape to digital tape and direct transmission of digital image to a computer. In these circumstances, a digital video camera system for human motion analysis was developed by the authors.

This paper presents the concept of a digital video camera and shows examples obtained through tests.

1. INTRODUCTION

Video image sequences often give important information about dynamics of human motion in the field of sports training or rehabilitation.

The authors have been concentrating on developing a video theodolite system consisting of a CCD camera, a theodolite and a video recorder where the camera rotation parameters can be determined in real-time while recording a human behavior. The effectiveness of the video theodolite system for dynamic analysis of human motion has been demonstrated (Chikatsu and Murai,1995, Chikatsu and et al.,1996) .

However, image data acquired using video theodolite system are analog data in spite of the fact that a CCD sensor is used. Similarly, image data acquired using a video camera are also analog and analog data cause a bottleneck for real-time human motion analysis.

For real-time human motion analysis, a digital video camera which make possible of direct transmission of digital image to a computer is expected.

With this motive, a digital video camera system for human motion analysis consists of 5 parts; camera, recording, image processing, control and display was developed. This paper discuss the concept and remarkable features of a digital video camera and experimental results are also reported.

2. DV CAMERA AND MPEG CAMERA

DV camera means that the digital video camera which is based on the DV format and use of DV camera is rapidly increasing. However, the DV terminal should be taken

note of from the view point of imaging and analysis since the DV image can be transmitted by the DV terminal, and the development of the DV terminal has not gone beyond the concept developed for the hobby user.
On the other hand, MPEG camera is another kind of digital video camera based on Moving Picture Coding Experts Group 1. Therefore, MPEG camera is not suitable for imaging and analysis since a clear image can not be acquired due to the MPEG1 format. Similarly, image processing for each frame is not possible because of MPEG1 format.

3. DIGITAL VIDEO CAMERA SYSTEM

The Digital Video Camera System developed by the authors consists of 5 parts; camera, recording, image processing, control and display. Figure1 shows the appearance and Figure 2 shows the system configuration. The more remarkable features of this system are as follows:

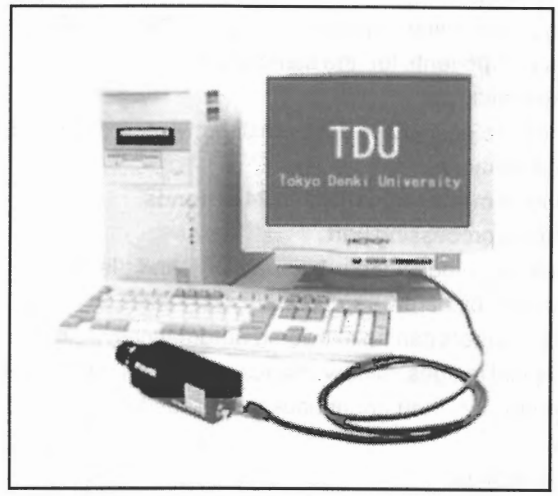

Figure 1: Appearance of the Digital Video Camera System

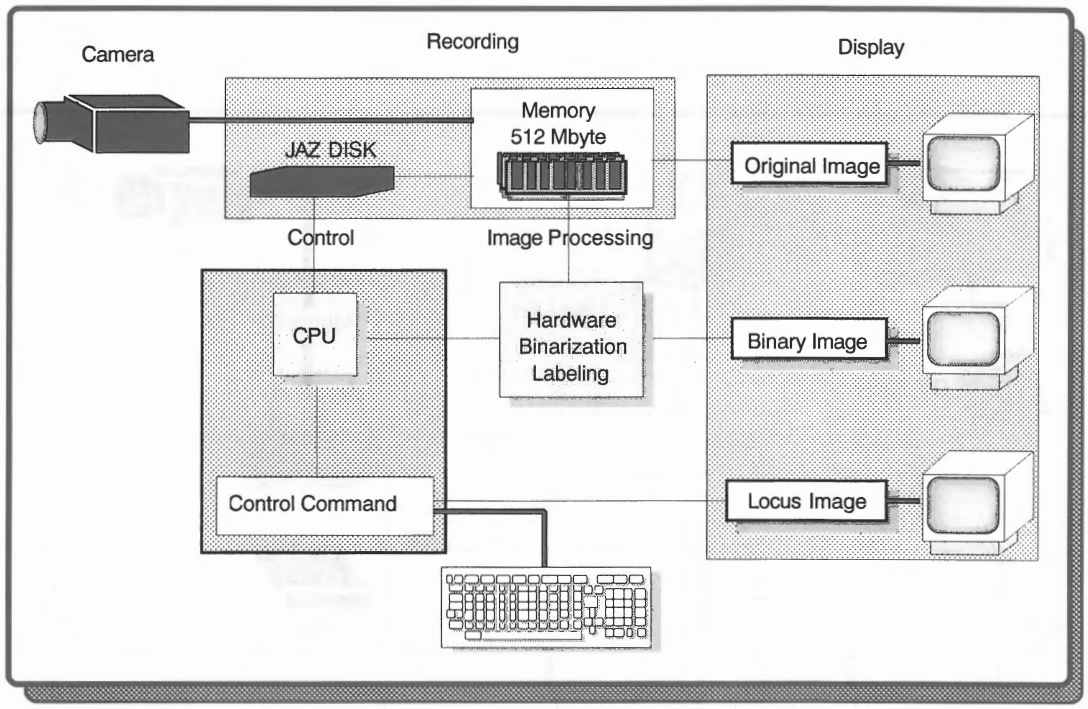

Figure 2: System Configuration

Table1: Major Components for the Camera Part

Pickup Device	Interline-transfer 1/2-inch size CCD
Effective Picture Elements	640(H)×480(V)
Cell Size	9μm×9μm (VGA Format)
Scanning System	Progressive Scan 525 line 60Hz
External Dimension	46(W)×39(H)×126(L)mm
Weight	250g
Lens	16mm C mount

● Camera part

+ Progressive scan system is adopted. Table 1 shows the major components for the camera part.

● Recording part

+ Original digital image data are directly recorded into 512 Mbyte memory.

+ 1440 frames are recorded in 24 seconds.

● Image processing part

+ Image processing, binarization and labeling are performed by hardware.

+ 100 markers can be extracted automatically.

+ Original images, binary images and coordinates, size of markers are then continuously recorded in 1Gbyte JAZ disk.

● Control part

+ Coordinates and size of markers can be read using the Excel.

● Display part

+ Locus for markers are displayed by the function.

Figure 3 shows the notable differences between the DV camera, the MPEG camera and the Digital Video Camera System.

4. EXAMPLES OF TESTS

A test for extracting markers which were fitted on human feature points such as the elbows, knees etc. were performed.

Figure 4 shows the original image for the test while walking using 18 markers. Figure 5 shows the binary image from which markers were extracted. Figure 6 shows the locus for feature points.

This system also is able to extract the whole human body. Figure 7 shows the original image while sitting and standing. Figure 8 shows the binary image for the whole body and Figure 9 shows the locus of area gravity.

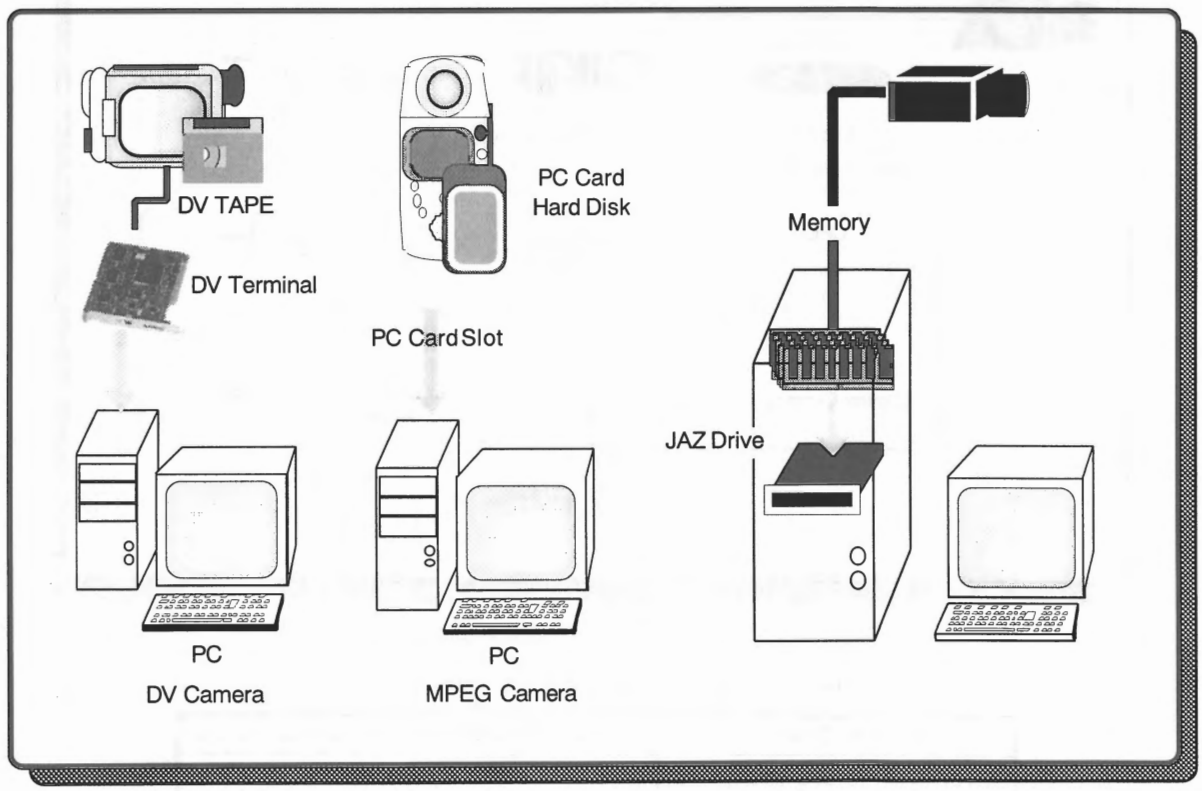

Figure 3: Notable Differences between Digital Video Cameras

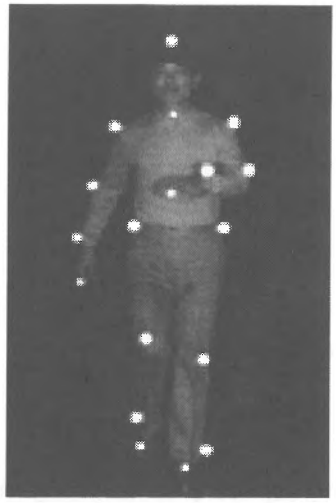

Figure 4: Original Image while Walking

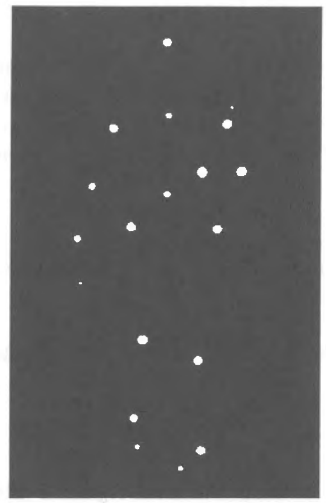

Figure 5: Feature Extraction

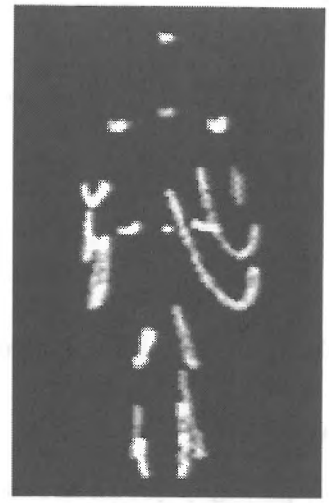

Figure 6: Locus Image

Figure 7: Original Image while Sitting and Standing

Figure 8: Binary Image

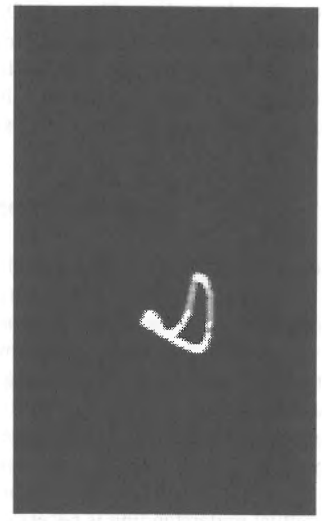

Figure9: Locus of Area Gravity

5. CONCLUSION AND FURTHER WORKS

Remarkable points for the Digital Video Camera System which was developed by the authors were described. Considering a real-time dynamic analysis of human motion for live animation has been performed using some markers fitted on the body. In order to understand a dynamic analysis of the most natural human motion and to take away mental and physical burden of a patient, any markers on the body should be removed.

Consequently, the digital video camera system is expected to become a useful instrument for real-time human motion analysis without any marker on the body.

There are still, however, some issues which need to be resolved before the Digital Video Camera System may become operational. These problems include recording speed and the handling of large volumes of data.

References:

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