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Extraction of Human Motion Based on Periodicity

O. Yoshinori Teduka and Toshio Koga
Graduate School of Science and Engineering, Yamagata University

1. Introduction
Recently security is increasingly important. It is very useful to automatically find unauthorized people entering restricted areas.

2. Extraction of Moving Objects
Moving objects are extracted using background images.
(1) A mask image representing motion parts is produced in binary representation, i.e. \( m^i(x, y) \) using three frames each being 1sec apart.
(2) The binary image \( m^i(x, y) \) is painted to produce another mask image \( M^i(x, y) \) by changing holes(0) inside moving regions to moving(1).
(3) Background image shown in Fig.1 is updated using the following equation.

\[
B^i_{m+1}(x, y) = \begin{cases} 
(1-\alpha)B^i_{m+1}(x, y) + \alpha I^i(x, y) & \text{if } M^i(x, y) = 0 \\
B^i_{m+1}(x, y) & \text{otherwise}
\end{cases}
\]

Fig.1 Background Image Production

3. Autocorrelation of Human Motion
When a person walks, hands and/or legs are moving periodically. This is one of remarkable characteristics peculiar to human motion, as shown in Fig.2.

The algorithm is composed of two processes. The first process calculates autocorrelation values in moving parts between frames, i.e. autocorrelation between frame(i) and frame(j). The dual pendulum in Fig.3(a) looks like motion of human hands or legs. Higher autocorrelation is darker on grids in Fig.3(b).

Fig.2 Human Motion example (Walking)

(a) Pendulum (b) Autocorrelation (c) Enlarged Fig.3 Autocorrelation of Pendulum Motion

The second process is discrimination of human motion. This is based on analyzing power spectrum of the autocorrelation image with FFT. The autocorrelation in Fig.3 gives two spectral peaks. Human walking is similar to pendulum motion, i.e. a human walking is in bipedalism. Figure 4 shows two peaks for human motion, similar to the pendulum motion.

Fig.4 Spectral power Histogram

4. Conclusion
This paper shows a possibility of human walking detection based on periodicity of the motion.

5. References