

Performance Evaluation in Weightlifting Using Full Search Algorithm

Kuruppu KADG¹
Pinidiarachchi A²

ABSTRACT

This paper presents a technique for high speed weightlifting trajectory analysis and path recognition for athlete's performance evaluation. The primary aim of the work is tracking bar traveling path. Block Matching Algorithm (BMA) which is a standard technique for encoding motion in video compression algorithms is used and Full Search (FS) algorithm of BMA is tested for its accuracy. The results obtained show that FS algorithm performs with high accuracy for high speed object tracking.

KEYWORDS: Trajectory Analysis, Sports Biomechanics, Image Processing, Computer Vision, Weightlifting

INTRODUCTION

With the advent of computing technologies and the increase in their usage, use of computer science for sports activates has also increased over the years. Hawk eye is one such commonly used popular computing technique that is widely used in sports like cricket. V-scope is another popular technique that is used to evaluate the performance of weightlifters. The type of data that can be acquired for a snatch, (see Figure 1) is shown in Figure 2. These data is very important to prevent technical faults in an athlete. However the high cost associated with techniques like this, prevents them from being used commonly specially in developing regions of the world.

Image processing techniques like Block Matching Algorithm (BMA) have been used successfully in trajectory analysis applications. Compared to the type of data provided by a method like V-scope, these techniques can be used to capture more details on the trajectory in an easy and cost effective manner.

¹MPhil Student, Postgraduate Institute of Science, Faculty of Applied Sciences, Wayamba University of Sri Lanka.

²Senior Lecturer, Department of Computer Science and Statistics. University of Peradeniya.

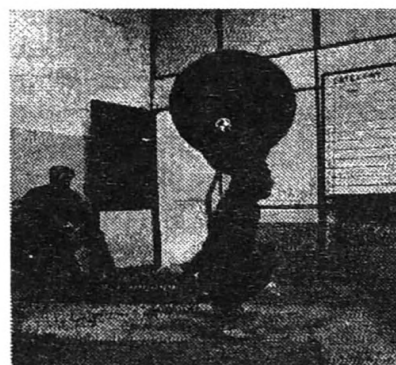


Figure 1: Weightlifting Bar Trajectory

In BMA there are nine Search techniques In BMA there are nine Search techniques namely Cross Search Algorithm (CSA), Full Search Algorithm (FSA), Spiral Search, Three Step Search, Two Dimensional

Logarithmic Search (TDL), Binary Search (BS), Four Step Search (FSS), Orthogonal Search Algorithm (OSA), Hierarchical Search Algorithm (HSA)). Out of these nine methods, FS is considered to be the most accurate search technique. One advantage with FS is that it can give accurate results even on low resolution video.

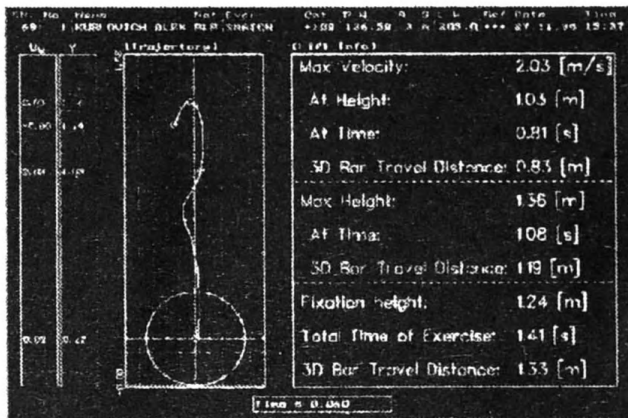


Figure 2: Scope Trajectory Details

OBJECTIVE

The key objective of this study is tracking the high speed motion and the accurate path for sports bio mechanics purposes. It is also expect to find an accurate method that allows obtaining these results in real time processes.

METHODOLOGY

The major task of this research is tracking and matching bar movement of video sequence video format is MPEG-2 (avi) 30fps, 800px with and 600 px width. One way to track the trajectory using Block matching Algorithm (BMA).Main aim of BMA is detecting motion between two images. The blocks are defining by the non overlapping square parts. Each frame matches from current frame to destination frame. Then sum of gray values each the minimum value is best match of the block. Defining block size is difficult task. Blocks are less sensitive to noise, but block process time is very large. There are 9 BMA types. Full Search Algorithm has the highest accuracy[3]. Sum of the difference of the luminance of pixel located at the same position in two blocks to compare two blocks. There are two algorithms to perform this calculation.

Let $c_i(x,y)$ detect the luminance of pixel (x,y) in block i . Mean Absolute Difference (MAD) given by equation (i). Another cost function is Mean Squared Error (MSE) given by equation (ii) where N is the side of the macro bock, C_{ij} and R_{ij} are the

Pixels being compared in current macro block and reference macro block, respectively. We use MAD because MSE is use take more time to calculate because squire. When MSE is 0 then two blocks has same pixels. In practical situation we get the smallest MSE to find best match block.

Full search compare every frame of the source block. The calculation cost of this algorithm is very high but accuracy also very high. Implement of this using Java IDE is Netbeance 6.8.

Height of the bar travel distance is another important thing. Weightlifting rubber disk diameter is 45 mm. then we get the ratio of the rubber disk and bar starting point and ending point pixels to find height of the bar traveling distance. It can also calculate speed of the bar. Only this implementation can feed manually. It is going to implement Hugh transform to detect automatically rubber disk and get calculate the height.

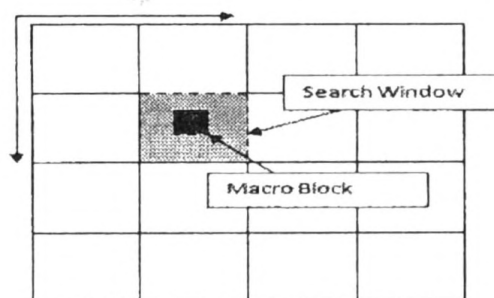


Figure 3: Block matching search area

$$MAD = \frac{1}{N^2} \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} |C_{ij} - R_{ij}|$$

$$MSE = \frac{1}{N^2} \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} (C_{ij} - R_{ij})^2$$

- (i) Mean Absolute Difference
- (ii) Mean Squared distance

Equation 1: Block matching cost function

DATA COLLECTION AND ANALYSIS

All the image sequence are getting in 25fps normal camera. Collect all the data from

Kurunegala, Kandy and Colombo weightlifting national level gymnasiums. All the athletes are Sri Lanka national level players. Camera angle is perpendicular to weightlifting bar. Capture video format is MPEG -2 and convert all the video to JPEG image sequence.

RESULTS AND DISCUSSION

All the image sequence tracking programme and manually. And get x and y positions of the trajectory was obtained for comparison. See Figure 3. In slow motions manual data and FS data almost same but speed motions there are slide differences as can be seen in the figure.

When considering the efficiency of the method FS Calculation time is very high. It takes average 20 minutes to tracking single frame.

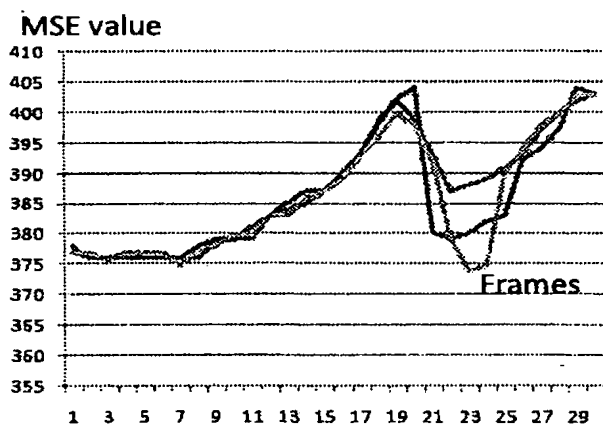


Figure 4: Comparison of the Trajectory

CONCLUSION

In this paper we presented Block matching algorithm for motion estimation with the aim of performance evaluation in weightlifting. Full search algorithm gives accurate result for high speed tracking. However processing time is very high and will become a major concern when real time processing is required. Optimization method like genetic algorithms can be used to enhance the performance. Normal consumer video camera cannot capture high speed motions. More accurate result could be obtained by using 100fps video camera.

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