Trajectory Analysis for Performance Evaluation in Sports

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ABSTRACT

This paper describes an approach to Trajectory Analysis for Performance Evaluation in Sports. In video surveillance and sports analysis applications, object trajectories offer the possibility of extracting rich information on the underlying behavior of the body movements. This information is used in sports for biomechanics corrections. This paper mainly focuses on trajectory analysis of weightlifting bar motion in image sequences captured from a video camera.

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

INTRODUCTION

Since early days of civilization, sports have been part of human lives. It has always been evolving and today, almost every sport uses modern high-end technology both in training and evaluation processes. Use of new technology has been emphasized by the fact that there are limitations to the monitoring process carried out by naked eye. It is also realized that, the use of these technologies would enable a sportsman or a team to be successfully ranked internationally. In the Sri Lankan context, techniques like Hawk-eye(Wikipedia, 2009) are used in cricket. However, other sports like weightlifting, high jump, long jump, hurdles and so forth rarely use new techniques. Such techniques are not used mainly due to their high cost. In rugby a Global Positioning System (GPS) technology is used in GPS-Route to measure the running path and ball throwing path. This technique is also used in bicycle riding, marathon and so on. A special body kit is used in this method and the technique tends to be of very high cost. V-scope(Dynamic-eleiko, 2009), a popular technique that is used to evaluate the performance of weightlifters .The type of data that can be acquired for a snatch, Figure 1, using the v-scope this can be seen in Figure 2.

These data are very important to prevent technical faults in an athlete. The reason for this technique to be not used is also its high cost.

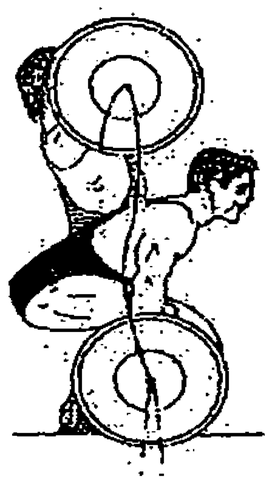

Figure 1-weightlifting Snatch Trajectory

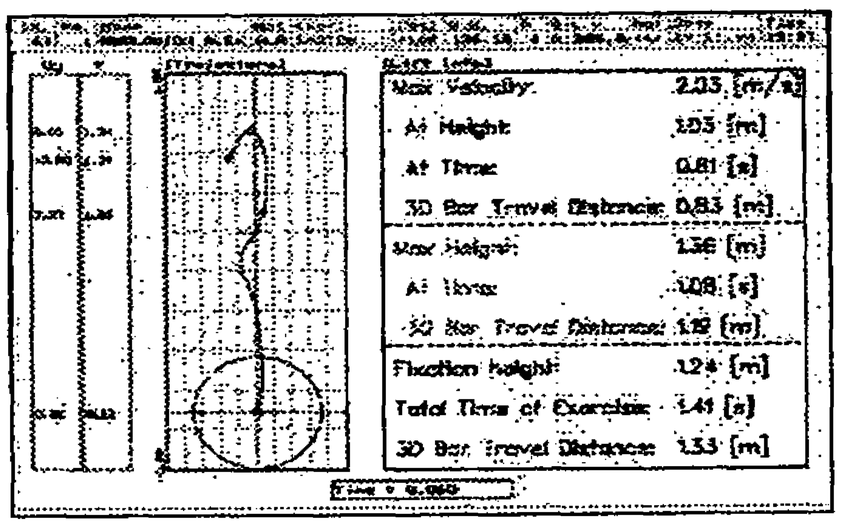

Figure 2- V-Scope Trajectory and data table

RELATED WORK

Various attempts have been made to develop tracking algorithms using image processing. Snatch technique validation using the computational method is discussed in (Amir H.Javadi, Ahmed R. Arshi, Elham

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Shirzad ,2007). The motion analysis is preformed using WINanalyze motion tracking software. The data input using single digital camera plane at a right angle received at 125 fps(Frames per second) is used. This work is mainly targeted in injury prevention of weightlifting snatch techniques.

This evaluates athlete body motion and targeted in weightlifting snatch technique only. However they have only targeted body movements for weightlifters and the method cannot analyze bar movement's trajectory.

The work presented in (Bodo Rosenhahn, Christian Schmaltz, Thomas Brox, Daniel Cremers , 2008) is mainly targeted in marker-less motion capture. Cyclist and Snowboarder's are analyzed trajectory with the feet. The method tracks smooth motion pattern (Cycling) and pattern with fast contact (jumping). They use pedal axis as an end point of a bike and captured using four cameras (100fps). A limitation of this work is that the visible areas vary from place to place and several view points are used to deal with it.

Trajectory analysis for sports and video surveillance was discussed in article (Y.L.de Meneses, P.Roduit, F.Luiaier, J.Jacot , 2005). They tried to analyze trajectory of sports cars in a close circuit path using several lap records and analyzing each lap trajectory. It measure main path using a Point Distribution Model (PDM). They build a sample model and test using radio-guided cars. Main problems in this work are the difficulty in getting real world information and comparing with different data as it depends on car driver styles.

Monocular 3-D tracking of the Golf swing was discussed (Raquel Urtasun, David J.Fleet, Pascal Fua, 2005) .This work was targeted in monocular tracking of human motion of golf swing. They consider an image and try to remove background without a golfer. Main problem they identified is that the background is not static, and they cannot expect to be of very high quality. They also considered that golfer is wearing untextured clothing.

Most common problem in many of these methods is the need to attach some equipment for gathering data. This might not be feasible since athletes may not allow this all the time. In addition, the works discussed above are mainly concerned with gathering and analysis only. One most important aspect related to performance in sports like weightlifting is comparing the obtained data with data from an ideal person (World Champion) in order to evaluate the level of performance.

PROPOSED WORK

- **Aim**

Winning medals in Olympics, World championships and Asian Games is rare for athletes from south Asian countries. Very closest reason for this is that they are poor in techniques. To overcome this, athletes need to use biomechanical technology. However the equipments that support this are very costly and hence unavailable. The aim of this project is to explore areas of sports where trajectory analysis and tracking are used as a means of performance evaluation and to develop a method that could assist on such evaluation criteria, thereby helping the athletes to improve their techniques up to the world standards.

Technically, the aim of this research is identifying path of moving object (e.g. athlete) and tracking their trajectory using video sequence. The sequence would track unique point like weightlifting bar. Using this trajectory information it is possible to calculate what is starting speed, middle speed maximum height, how far moving path is vary from middle point and how different from ideal persons trajectory, for example first pull, second pull details from weightlifting and maximum height from long jump.

RESEARCH PLAN

In this research, trajectory analysis methods used for different sports and other video sequences will be analyzed. A model that can be used in sports for marker-less tracking will be developed in order obtain the path and to acquire data like speed, acceleration, velocity etc. A marker-less tracking approach will be explored since in many situations attaching objects like sensors are undesirable. To evaluate the developed methods, weightlifting image sequences will mainly be used since ground truth data for world top ranked weightlifters could be accessed through the world weightlifting federation. The developed methods does not necessarily be limited to one sport but is expected to be flexible enough to be extended for many sports where marker-less object tracking is desired tracking. At initial stage testing will be carried cut using MATLAB since it can be used effectively for initial testing of methods. The final system is expected to be developed using Java which is the most popular object oriented programming language and it could be used to implement an efficient standalone application.

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