ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 07, Issue, 10, pp.15761-15764, October, 2017

ORIGINAL RESEARCH ARTICLE

OPEN ACCESS

INVESTIGATING THE CENTER OF PERCUSSION (COP) OF CRICKET BAT USING ACCELEROMETER SENSOR – A PILOT STUDY

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ARTICLE INFO

Article History:
Received 06th July, 2017
Received in revised form
25th August, 2017
Accepted 27th September, 2017
Published online 10th October, 2017

Keywords:

Center of Percussion COP),
Accelerometer sensor and vibration.

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ABSTRACT

The purpose of this study was to find out Investigating the Center of Percussion (COP) of Cricket Bat. To achieve the purpose of the study, cricket bat (reebok yuvi burn) was selected by the investigator. The variable selected for this study was Center of Percussion (COP). To measure the Center of Percussion (COP) accelerometer sensor was used. The collected data were statistically analyzed by the repeated measures design of ANOVA. In all the cases 0.05 level significances was fixed. It was concluded that the Middle of the Bat (MoB) had lesser vibration ranges 5-7cm when compared to Bottom of the Bat (BoB) and the Top of the Bat (ToB).

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Citation: Dr. Raj Kumar, M., Dr. Prabhu Pandian, P. and Rajesh Jeyakrishnan. 2017. "Investigating the Center of Percussion (COP) of Cricket Bat through Accelerometer Sensor – A Pilot Study, *International Journal of Development Research*, 7, (10), 15761-15764.

INTRODUCTION

The world of sport is continually changing over the years, and the use of technology is just one of those areas that have made an impact on many sports in the modern day. See the annual sports technology awards for the latest technology ideas in the world of sport. One criticism of the use of technology is that it can slow down the speed of the game, but on the other hand for many people it makes watching it more enjoyable to see the correct decisions being made.

Tennis - it is now standard at the major tennis tournaments for a line review system to be in place, with players given power to review contentious line calls. It is powered by the Hawk-Eye ball tracking system.

Soccer / Football - Soccer is looking at joining the 21st century, looking at various technologies for the goal line to determine if the pass passes over the line or not.

Cricket - technology in cricket has been driven by advances in the TV coverage. Things that were once extra information provided by the TV networks are now being incorporated into the decision referral system (DRS), such as hawk-eye and hot spot, and maybe even the old favorite snicko. In an age when athletes have access to more advanced training techniques than ever before, the landscape of sports is entering a new realm. Today, it is not enough for an athlete to simply possess superior strength or talent. To rise above the competition, the modern athlete must train intelligently and use the most innovative techniques to outfox opponents. And technology can help with that.

Tracking Technology

Advancement in modern training is tracking technology. These devices have the ability to provide intelligent feedback on various physiological properties. Sensors embedded in jerseys can now track a player's performance metrics in order to calculate their risk of being injured, and they can also alert them when it is safe to return to play. Professional teams have been quick to invest in this kind of "smart" fitness clothing. Clothes aren't the only items providing feedback. Trainers and coaches now have the ability to track multiple players at once through embedded sensors in fields and courts. Analysis of game data then reveals multiple strategies for improving performance. Sports scientists are now well aware of the disparity in training emphasis between the brain and the body and are developing methods to strengthen neuromuscular circuitry. For example, neurostimulation devices, when paired with athletic training, promise to help strengthen and optimize connections between the motor cortex and the muscles, leading to measurable increases in strength, explosiveness, and motor skills.

Benefits of Technology

Analysis of performance and training efficiency Adapt training based on test results to increase performance and prevent injuries Make return-to-play decisions based on reliable data Secure investments through regular testing and qualification Highlighting of differences that are not visible on video. Several measurement approaches have been used to examine the performance of elite athletes today. It is most commonly done in a laboratory where physiology and biomechanics can be tested and analyzed. Moreover, the performance of elite athletes is also measured during competition. These measurements enable coaches to effectively work with athletes to enhance their performance. Advancements in microelectronics and micro technologies have facilitated measurement of elite athletes in a natural training environment.

Centre of Percussion

The center of percussion is a point on a pin-supported object where a perpendicular impact will produce no reaction force at the pivot point. In baseball, the centre of percussion on a baseball bat is known as the "sweet spot". This is the location on the bat that is generally regarded as the best spot for hitting the baseball. It minimizes vibration of the bat and results in the maximum energy delivered to the ball, meaning it travels the farthest. The "sweet spot" is a special point on the bat. When the ball strikes there, the result is minimal stinging of the hands at the grip location on the handle (the pivot). Baseball players claim that hitting the ball in this location "feels" the best, and results in the mostsolid hit.

COP in Cricket

Batsmen generally try to hit the ball at the 'middle' of the bat. This is not the literal meaning; it is situated near the end of the bat where the largest thickness of the bat is. It is also known as the sweet spot.When the ball hits the bat, it causes the bat to be pushed backwards but due to the forward rotation ofthe batsman's hands (to strike the ball high) a forward force is also present and therefore two oppositeforces of different values cause a 'sting' to the batsman's hands. This making it harder to play far shots as it would hurt too much! If however the ball is struck at 'the middle of the bat' which is scientifically known as the centre ofpercussion, a vibration occurs at the fundamental node of the bat, both forces mentioned before cancelout and there is no force felt in the batsman's hands.

Centre of percussion – *determined practically*

The centre of percussion can also be estimated practically without using any calculations. To find thecorresponding node to the fundamental mode, grip with your fingers and thumb about six inches from thetop of the handle. Hit the bat at various points with an impact hammer. The point where you feel novibration and hear almost nothing is the node or the centre of percussion. If the bat is hit below the centreof mass but above/below the centre of percussion, the hand will feel a jolt. If it is hit at the centre ofpercussion, the hand will feel nothing.

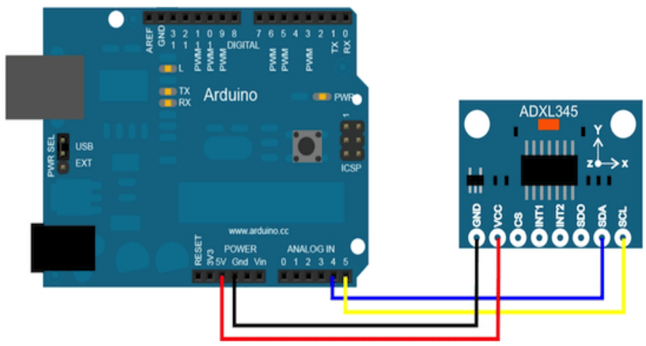
Accelerometer

Athletic and clinical testing for performance analysis and enhancement has traditionallybeen performed in the laboratory where the required instrumentation is availableand environmental conditions can be easily controlled. In this environment dynamiccharacteristics of athletes are assessed using treadmills, rowing and cycling machines and even flumes for swimmers. In general these machines allow for the monitoringof athletes using instrumentation that cannot be used in the training environment butinstead requires the athlete to remain quasi static thus enabling a constant field ofview for optical devices and relatively constant proximity for tethered electronicsensors, breath gas analysis etc. Today however by taking advantage of the advancementsin microelectronics and other micro technologies it is possible to buildinstrumentation that is small enough to be unobtrusive for a number of sporting andclinical applications (James, Davey and Rice 2004). One such technology that hasseen rapid development in recent years is in the area of inertial sensors. These sensorsrespond to minute changes in inertia in the linear and radial directions. These are290 Daniel A. Jamesknown as accelerometers and rate gyroscopes respectively. This work will focus onthe use of accelerometers, though in recent years rate gyroscopes are becoming morepopular as they achieve mass-market penetration, thus increasing availability and decreasing cost and device size.

Accelerometers have in recent years shrunk dramatically in size as well as in cost(-$US20). This has been due chiefly to the adoption by industries such as the automobileindustry where they are deployed in airbag systems to detect crashes. Microelectromechanical systems (MEMS) based accelerometers like the ADXLxxx seriesfrom Analog Devices (Weinberg, 1999) are today widely available at low cost. Theuse of accelerometers to measure activity levels for sporting (Montoye, Washburn,Smais and Ertl 1983), health and for gait analysis (Moe-Nilssen, Nene and Veltink2004) is emerging as a popular method of biomechanical quantification of health andsporting activity and set to become more so with the availability of portable computing,storage and battery power available due to the development of consumer productslike cell phones, portable music players etc.

Literature review

The methodology used for baseball bat research is used for cricket bat. Lloyd Smith et al in their paper determined dynamic interaction of bat and ball. Linear elastic property was used for bat and nonlinear property for ball. The bat and ball was given linear velocities. The effect of impact location on ball exit velocity was presented. Rochelle Nicholls et al analyzed the dynamics of bat ball impact using finite element method. Kinematic input was obtained from experimental setup. Aluminium and wood baseball bat was used for analysis. Linear elastic isotopic model was used for bat. Both ends were assumed to be free to rotate and translate. Results between ball exit velocity and impact location is plotted to determine the location of maximum BEV. Sherwood et al analyzed the change in the performance of bat due to changes in wall thickness, handle flex, material properties, and weight distribution. Experimental data was calibrated using finite element method. Mooney rivilin material model was used for ball. Automatic surface to surface contact algorithm was selected. Aluminium bat made of C405 alloy was considered and meshed using shell element. Solid wood bat was also used for analysis. Graph was plotted between BEV and time for wood and aluminum bats. Aluminium bat had higher ball exit velocity.



Arrangement

The cricket bat suspended vertically with wired accelerometer sensor at the back of the bat.

Table I. Summary of mean and repeated measures of anova for the Center Of Percussion (COP) (BoB vs MoB vs ToB)

Mean ± SD			Source of Variance	Sum of Squares	df	Mean Squares	'F'- Ratio
Bottom of the Bat (BoB)	Middle of the Bat (MoB)	Top of the Bat (ToB)					
119.7	128.05	120.5	Between	849.1	2	424.55	6.01*
± 9.93	± 7.06	± 4.94	Within	2682.23	38	70.58	

*Significant at 0.05 level of significance force was scored in mG

(Table value required for significance at .05 levels with df 2 and 38 is 3.24)

Table I shows that obtained F-ratio among Bottom, Middle and Top are 6.01 which are greater than the table value of 3.24 with df 2 and 38 at .05 level of significance. It was concluded that there was significant difference among the bottom, Middle and Top on COP (Center of Percussion). Since the obtained F-test was significant, the Tukey HSD test was used to find out the paired mean difference and the results have been presented in table II.

Table II. Tukey HSD test for the differences between paired means on Center Of Percussion (COP) (BoB vs MoB vs ToB)

Mean(mG)			Mean Differences	Confidence Interval
Bottom	Middle	Top		
119.7	128.05		8.35*	6.48
119.7		120.5	0.80	6.48
	128.05	120.5	7.55*	6.48

From the table II shows that the mean differences on force between bottom of the bat (BoB) and Middle of the Bat (MoB), and Middle of the Bat (MoB) and Top of the bat (ToB) were 8.35and 7.55 respectively which were statistically significant at 0.05 level of confidence. The mean differences on force between bottom of the bat (BoB) and Top of the bat (ToB) were 0.80 were statistically insignificant at 0.05 level of confidence.

Shenoy et al compared the performance for wooden bat and composite bat. The effect of bat constraints on stress and performance is determined. Graph were plotted between hit ball speed and bat impact location and Bat impact location and axial stress.

Larry noble provided scientific basis for examining and developing new bat design and manner in which bat is swung and forces transmitted during swing and properties of bat were considered. Mass, Moment of inertia, Coefficient of restitution, COP and Fundamental node of vibration were the properties considered. The study is made on the cricket bat. The present concentrates the characterizing of 7 cricket bat and its performance. Various Graphs are plotted for ball exit velocity and impact location from bottom of the bat.

Experimental arrangement

To measure

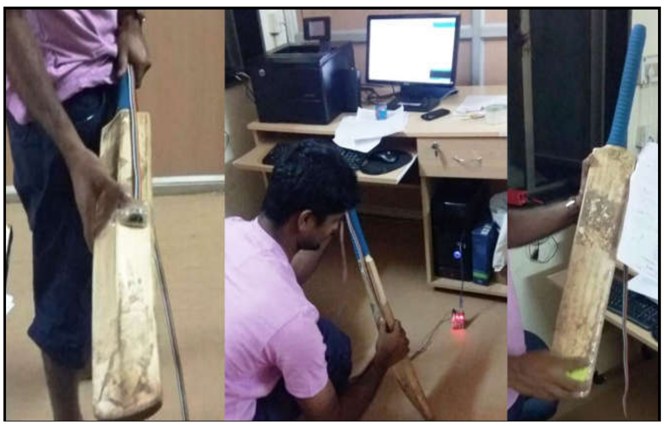
To calculate COP (center of percussion)

Essential equipment

Cricket bat, Wire, Accelerometer sensor and Computer system with Arduino Software

The investigator measures the cricket bat in to three different region Bottom bat (Measures from toe of the bat to 18 cm), Middle bat or sweet spot (measures from the toe to 20 – 26.5 cm) and Top bat (Measures from 26.5 cm to shoulder of the bat).

Experimental procedure



The investigator taps the hard tennis ball towards the cricket bat on each region namely Bottom, Middle and Top. The investigator holds the bat with one hand and start tapping the hard tennis ball towards the designated region i.e., Bottom, Middle and Top.

Collection of data

The data were collected by by tapping the hard tennis ball (20 times) on each mentioned region (Bottom, Middle and Top). The investigator gets three axis data (x.y,z). For statistical purpose only x-axis were considered.

Statistical technique

Studies that investigate either change in mean scores over three or more time points, or differences in mean scores under three or more different conditions. The same cricket bat measures in three different regions (Bottom, Middle and Top). Hence, the investigator adopts the repeated measures design of ANOVA. In all case, Level of significance (0.05) is fixed to test the hypothesis.

Conclusion

From the study investigator determined that the Middle of the bat can sustained more force. It shows that the batsman can feel less or no vibration on their hands, especially when ball hits on its middle of the bat.

REFERENCES

https://qz.com/749746/human-athletes-are-using-training-technology-from-the-future-to-become-more-like-robots/

http://www.real-world-physics-problems.com/center-of-percussion.html

http://www.topendsports.com/resources/technology.htm

https://www.kistler.com/ie/en/applications/sensor-technology/biomechanics-and-force-plate/sports-performance-analysis/

https://www.azosensors.com/article.aspx?ArticleID=151

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