iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** III **Month of publication:** March 2018

DOI: http://doi.org/10.22214/ijraset.2018.3146

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

Technical Aspect of Cricket Bowling Machine

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Abstract: ***This paper deals with technical aspect of cricket bowling machine which is consist of a pair of adjacent wheels, each provided with a groove or concave surface formed in the body of an viscous-elastic material. And in this machine two high speed DC motor has been used. These two wheels are mounting over the motors. The whole setup are placed on a tripod, whose height and angle of projection for ball throwing can be manually adjustable with tilting mechanism for angular adjustment of the rotational plane of wheel. The pulse width modulation is device which varies the speed of the driving wheels of two motor with microcontroller. Pulse width modulation is the process of switching the power to a device on or off at a given frequency which causes the variation in speed of balls for swing and spin bowling.***

Keywords: ***DC-Direct Current, PWM-Pulse Width Modulation, Microcontroller, Cricket, SCR-Silicon controlled rectifier, MOSFETs, IGBTs.***

I. INTRODUCTION

The concept of the cricket bowling machine provides accurate and consistent bowling practice for cricketers. There are a several ball throwing machine are developed such as follows; (1) Machine that works on the pneumatic pressure to propel the ball; (2) Machine that set down a spring operated mechanism or elastic member to throw the ball; and (3) Machine that employ at two rotating wheel to throw the ball. Since the successful launch of the first BOLA in 1985 which was purchased by Surrey Country Cricket club and then used in England Cricket side. This have encourage the continuous improvement and development of this machine. Main mechanism of this machine consist of two heavy wheels of diameter 28 to 50 cm with rubber tires where each rotated by its own electric motor.[3] Mostly available cricket bowling machines set down one rotating wheel or two co-acting rotating wheels, which are used to throw a ball that introduced between two rotating wheels. However, each category of machine have certain advantage, disadvantage, and obviously there are few excluded limitations. The first machine pneumatically operated cricket bowling machine uses a compressor actuated by a motor to produced highly compressed air into throwing pipe. This type of ball throwing device occupies a lot of space, it is not very much economical and portable.[4] The spring actuated machine set down a throwing mechanism consisting of spring to throw ball in projectile. In this machine the difficulty is faces in designing a controllable actuating mechanism for delivering ball. Moreover, this device provide only limited direction control of the ball as it is released and incapable of simulating the flight characteristic of a normally delivered ball. The third type of bowling machine is one which is operated by action of one or more wheels mounted over a motor which deliver the ball when it comes in contact with the rotating wheel. In this type machine the gap between two counter rotating wheels is fixed and are mounted on a base for axial rotation in common axis. The base is supported on a tripod. The tripod gives the angular motion as well as projection from different heights.[4] There is appropriate friction between the ball and the wheels. The plastic wheels with rubber belt are the most commonly use. This paper presents this machine is capable to delivered a cricket ball that bowls at various speed with change of directions and machine is adjustable to accommodate the throwing of cricket ball of different diameter like international standard balls and artificial practicing ball.[1]

II. PROPOSED BALL THROWING MACHINE

A. Mechanical Aspect

There are two rubber wheel bonded aluminium alloy which are mounted over the DC motor. Each wheel provided with a concave surface formed in body of an elastic material. This two wheels are mounted on base for axial rotation in a common plane, and the gap between the wheel should be slightly less than the diameter of a ball to be thrown and at last speed of each wheel can be adjustable separately. This machine transfer kinetic energy to the ball by frictional gripping of the ball between two rotating wheels. The base is provided by tilting assembly which is mounted on a bracket for angular adjustment of the rotational plane of the wheel about axis parallel to direction of release of ball and its perpendicular axis is possible. The speed of the two motors driving the two wheels is varied using the Pulse Width Modulation method. This gives the adjustments of relative speeds of rotation of plane gives wide variation in speed and swing of the ball. Cricket ball throwing machine consist of a nut and screw mechanism that

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allows the machine to tilt from its horizontal position and varied the length of ball by increasing and decreasing the angle of the ball by moving the head of the tripod. That allows us to change the length of the ball such as good length, full length or short length.[4]

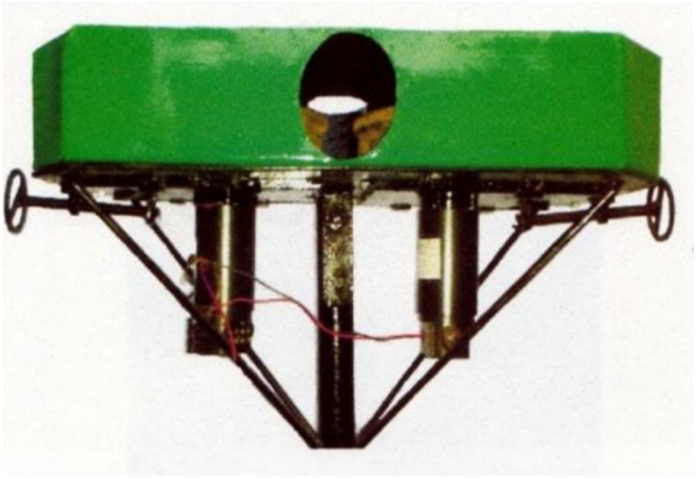

Fig 1. Sliding Arrangement

B. Electrical Aspect

The drive motors are electrically permanent magnet DC motor to adjust the rotational speed of each wheel separately. The operation of an electric motor is it always converts electrical energy into the mechanical energy. For mechanical power output at the shaft the DC supply is connected to the input of a DC motor. The speed control of a DC motor is done by pulse width modulation. Pulse width modulation is used as an efficient DC motor speed control. A current carrying conductor is placed in an external magnetic field it will experience a force propotional to the current through conductor and the strength of the external magnetic field. DC motor has six basic parts axle, rotor, stator, commutator, field magnets and brushes. In most common DC motors, external magnetic field is produced by high strength permanent magnet. The stator is the stationary part of the motor this includes the motor casing, as well as two or more permanent magnet pole pieces. The rotor rotates according to the stator. Electric motor is shown in fig 2. [2]

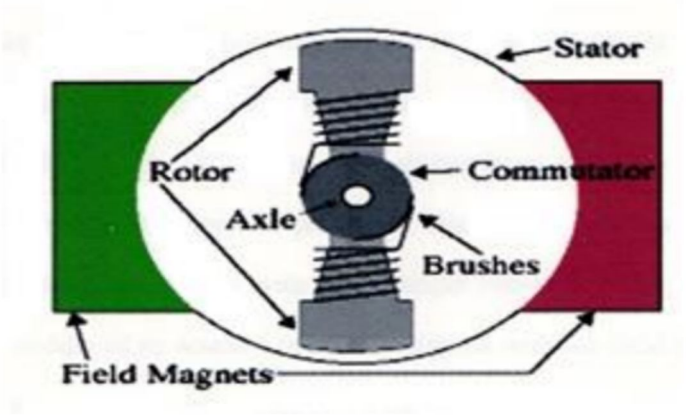

Fig 2 .Construction of DC motor

C. Control System

The electrical system the speed of DC motor can be controlled by using modern power electronics applications. However the power electronic device such as SCR, MOSFETs, IGBTs, etc., with the microcontrollers have variables speed drives system which are smaller in size and very effectively.[4] Pulse width modulation is a method for binary signals generation which has two signal periods high and low. The width of each pulse ranges between zero and the time period T. The primary principle is control of power by changing the duty cycle. Pulse width modulation speed control workes by driving the motor with a series of 'ON-OFF' pulse and varying duty cycle, the fraction of time that the output voltage is 'ON' compared with when it is "OFF", of pulses while the frequency keeping constant. The wave form of the pulse width modulation shown in fig 3. [4]

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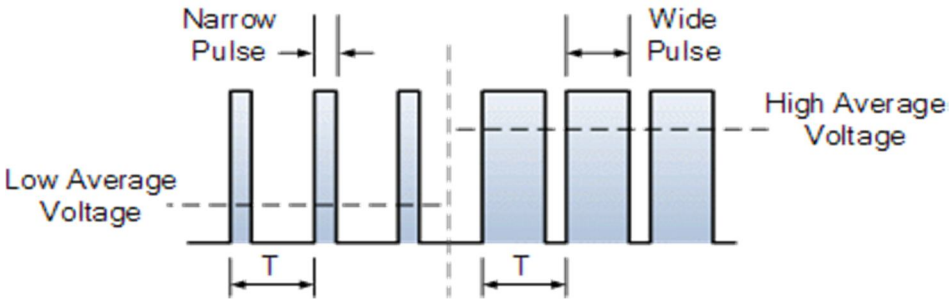

Fig 3 . Waveform of pulse width modulation

D. Swing Motion Of The Ball

The ball throwing machine is capable of having swing motion of the ball. When then motors are running at different speeds, swing bowling can be simulated. The magnus effect gives the direction of swing of the ball. The magnus effect is the phenomenon in which a spinning object flying in a fluid creates a whirlpool of a fluid around itself, and creates the force perpendicular to the line of the motion. The magnus force depends on the spin direction the front most point of the ball is turning is the direction of the force. Also the more spin gives to the ball, the more it will curve. This machine can achieve the both swings i.e. towards the batsman and away from the batsman.[6]

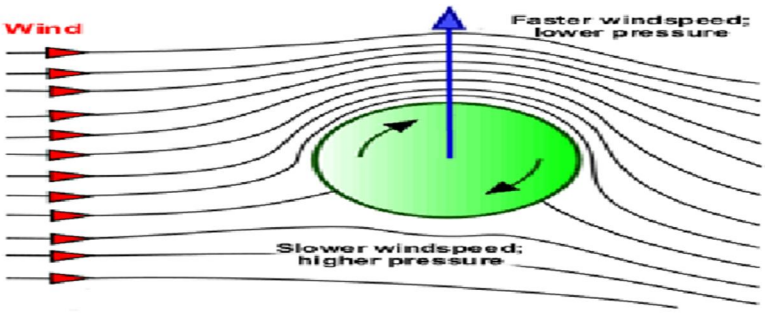

Fig 4. Magnus force acted on the ball

E. Rotating Speed Of The Wheels

order to eject the cricket ball from the throwing machine, two counter rotating wheel are used. Two forces of the wheel acted on the ball to be push at a high speed. The linear and angular speed of the ball depends on the circumferential speed of the wheels.[5]

$V=(V_1+V_2)/2$ $Wr_1=(V_2-V_1)/2$

Where; V_1, V_2 = Circumferential speed of the first and second wheel

And r_1= Ball radius after deformation.

III. TESTING AND RESULT

The result has tested and performed using a cricket bowling machine prototype dimpled ball and the basic speed measuring formula, with a distance being constant and the voltage being supplied to the motors being varied.

Table 1:- Various speeds at different voltage levels.[4]

Sr. No.	DC Voltage (volt)	Left wheel speed (rpm)	Right wheel speed (rpm)	Speed of the ball (km/hr)	Nature of swing
1	3	1600	1750	70	Out-swing
2	6	1900	1900	80	Straight
3	9	2300	2300	100	Straight
4	12	2500	2300	120	In-swing

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IV. CONCLUSION

In this paper an automatic bowling machine has been proposed. The batsman can practice by adjusting the bowling machine as per the requirement. The pulse width modulation used to controlling the speed of the dc motor. For 3V, 6V, 9V and 12V dc supply, it gives the speed from 70 km/h to 120 km/hr. The length of the ball being delivered can be varied by increasing or decreasing the angle of the ball by moving the neck of the tripod by using screw and nut mechanism.

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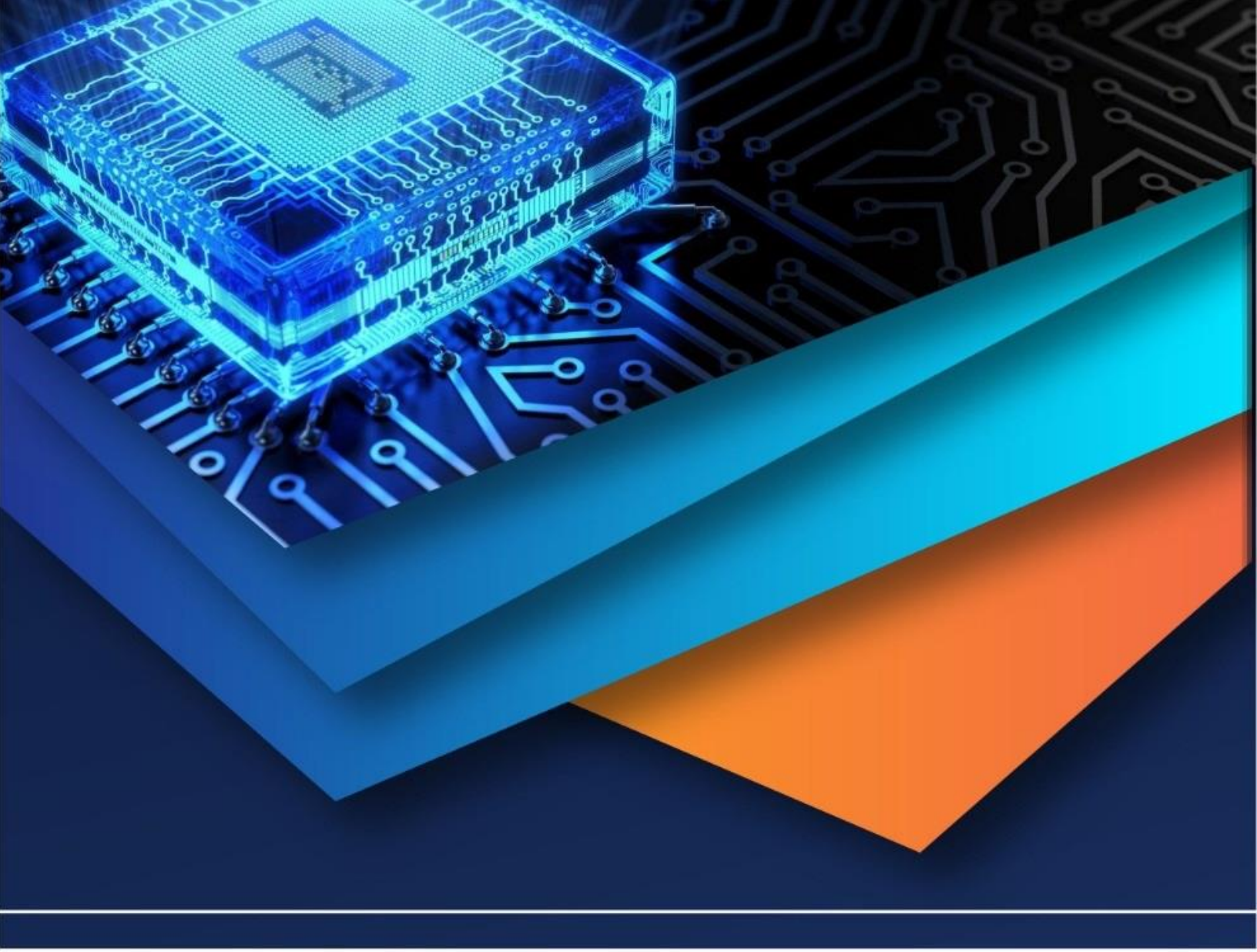

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