Design and development of indigenous cricket bowling machine

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Received 01 February 2005; revised 20 October 2005; accepted 12 December 2005

This paper presents details of a cricket bowling machine, developed at CMERI, Durgapur, which includes a pair of adjacent ball ejecting wheels, each provided with a groove or concave surface formed in a body of an visco-elastic material. These wheels are mounted on a base for axial rotation in a common plane, the spacing between the wheels being less than the diam of a ball to be thrown and the rotational speed of each wheel being adjustable independently of the other. This machine transfers the kinetic energy to the ball by frictional gripping of the ball between two rotating wheels. The base is supported on a tilting assembly, which is mounted on a bracket in such a way that the required angular adjustment of the rotational plane of the wheel about axis parallel to direction of delivery of ball and its perpendicular axis is possible. Electronic controls are provided for controlling the speed of rotation of the wheel. These adjustments of relative rotational speeds and plane of rotation of the wheels afford wide variations in the bowling speed, spin and direction.

Keywords: Bowling machine, Cricket, Indigenous

IPC Code: A63D1/00

Introduction

There are a number of ball throwing devices as follows: i) Machines that rely on pneumatic pressure to propel the ball; ii) Machines that employ a spring actuated mechanism or elastic member to throw the ball; and iii) Machines that employ at least one rotating wheel to throw the ball. One U S Patent discloses a pneumatic ball projector that utilizes compressed air for throwing the ball and also for causing the ball to follow a curve path, which may be controlled by the operator of the machine. Other patents on pneumatic ball throwing machines disclose ball projecting machines, which utilize friction strips or rails within a barrel to cause unequal drag on the thrown ball causing the ball to spin in a selected direction when ejected. This type of machine occupy more space, are high in manufacturing cost and not portable. Machines of second category (base ball, tennis ball and other balls) have been propelled by means of spring or elastic member. They are thus incapable of fully simulating the flight characteristics of a pitched ball. Majority of the commercially available ball throwing machines employ one rotating wheel or two co-acting rotating wheels, which are used to propel a ball that is introduced into nip between a plate and a single rotating wheel or between two rotating wheels. A pair of fixed spaced, counter rotating pneumatic tired wheels is mounted on a base for axial rotation in a common plane. Pneumatic tire type wheels have number of limitations. Principal ones are the requirement to maintain proper inflation pressure in order to ensure consistent ball gripping action, the frequency of wheel balancing to prevent wheel wobble and consequent erratic ball throwing and the excessive cost of such wheels and their maintenance. The device is not adjustable to accommodate balls of different diam and therefore a separate device is required for each different diam balls. Therefore, there is a need of an indigenous cricket-bowling machine that is capable of throwing a ball accurately and adjustably to a specific, predetermined location.

This paper presents design and development of an indigenous machine capable to produce a cricket ball that bowls at various speeds with change of directions and machine is adjustable to accommodate the throwing of cricket balls of different diam like international standards balls, synthetic practicing balls etc.

Proposed Bowling Machine

The machine (Fig. 1) consists of wheel mounting and sliding arrangement (01), rubber bonded Al alloy wheels (02), precise and positive tilting mechanism (03), motors (04), electronic control panel (05), chute (06), and stand with ladder (07). This device includes
fork type base member provided with opening portion at two ends of the base for receiving the wheel mounting and sliding arrangement (01) containing slider block, which holds a bearing to accommodate rubber bonded ball ejecting wheel and corresponding drive motor (04). The slider block can slide over the base member by means of a screw and nut mechanism, which is attached at each end of the base member for accommodating balls of different diam.

The rotary output shaft of the motor mounts the wheel (02) through bearing for rotation in opposite directions and in a common plane, which is parallel to the plane of the base member. The spacing between the confronting surfaces of the wheels is slightly less than the diam of the ball to be thrown. Accordingly, the ball is gripped between the rotating wheels and ejected in forward direction. Adjustment of the trajectory of a ball (Fig. 2), in order to have the ball arriving at the batsman’s position at various elevations relative to the strike zone, is accomplished by means of positive and precise tilting mechanism (03). The precision and reproducibility of ball pitches that is required for effective batting practices is achieved by adjusting the rotation of worm (08) and worm wheel (09) set precisely over a pre-determined range. A worm (08) is contained within the positive and precise tilting mechanism (03) and is supported on lower bracket (10). The worm (08) meshes with worm wheel (09), which is attached with top platform (11) by means of cap screws (12). The worm shaft (08) extends outwardly of the bracket and mounts a knob (13), by which the worm (08) is turned, which rotates the worm wheel (09), thereby rotates the base member.
The drive motors (04) are electric type, preferably permanent magnet DC in order to adjust the wide range of rotational speed of each wheel independently. The speed and direction of the ball mainly depend on the speed of two wheels, provided the gap between the two wheels is such that it has a good grip of the ball. The change of speed of the motors is provided by varying analog voltages generated through micro-controller (89C51) and associated peripherals. The flowchart and block diagram of the control scheme are shown in Fig. 3 and Fig. 4 respectively. By controlling the relative speeds of two counter rotating wheels, a spin can be imparted to ejecting ball and by changing the angle of the axes of rotation from horizontal, the spin can be imparted to the ejected ball, which causes it not only to drop but to curve to the left or right as well. The ball is received on chute (06) attached to base plate and the wheels. The wheels are rotated in opposite directions and spaced to receive a cricket ball there between for ejecting the ball tangentially forward.

Each of the wheels includes a rigid central portion of cast aluminium alloy suitably having a flat cylindrical rim and elliptical arm for supporting a body of visco-elastic material. Each visco-elastic body is formed with a peripheral groove providing a concave cross-section extending circumferentially around the perimeter of the wheel for receiving a ball and for channeling the trajectory of the ball when the wheel rotates. The wheels are generally spaced more closely together than the diam of the ball and the visco-elastic material is compressed when the ball is received between the wheels. As a result of this compression, the filleted edges spread laterally and outwardly when receiving the ball and provide a finger-like grip on either side of the ball, which is effective for gripping and controlling the trajectory of the ball. Various materials may be employed for the visco-elastic body. In the present work, visco-elastic body was formed by synthetic rubber capable of providing resilience (5-12D Durometer).

**Results and Discussion**

A prototype of the bowling machine (Fig. 5) has been designed and fabricated at CMERI, Durgapur. The key features of the developed machine are: i) Adjustable bowling speed in 2 km/h increments from 70-160 km/h; ii) Weight of the machine, 34 kg; iii) Height of the delivery point of the machine, 200 cm; iv) Positive and precise adjustment of line and length using worm-wheel mechanism; v) Developmental cost of the machine, Rs. 75,000; and vi) Range of diam of the ball to be thrown, 65-75 mm. In the normal functioning of the machine, the ball comes out of the chute and reaches space between the two wheels and is thrown straight towards the practicing batsman. In case of swing of the ball, a differential speed is maintained of the two wheels. To create a twist on the ball of different kind, a differential speed is maintained between two wheels and at the same time tilting platform is either inclined towards the left or towards the right with respect to fixed L-frame, according to the kind of the spin. To control the
length of the bowling, the tilting platform is inclined upward or downward, as the case may be. Inward or outward sliding of the two wheels with the help of slider block and screw-nut mechanism will enable the throwing machine to accommodate balls of different diam, which is not available in any foreign machine. In the present experiment, the bowling speed and nature of swing were measured by professional broadcasting camera (Video Hi-8 Camcorder, Model no: EVW 300P) with editing software Avid MCXpress for Macintosh (Table 1).

Conclusions
The bowling machine of the present work, by imparting rotation to the ball, causes the flight characteristics of the throwing ball to simulate those of a pitched ball thus making the machine suitable for use in batting, fielding and keeping practice. The inventive steps of the present system rests in designing and developing precise and positive tilting mechanism, the special kind of ball ejecting wheels and wheel mounting and sliding arrangement provided to change the location of the wheels with respect to each other to hold and throw different kinds of balls. The proposed bowling machine has the following advantages: (i) The bowling speed is variable (70-160 km/h); (ii) Positive adjustment of line and length of bowling are possible with repeatability; (iii) Different varieties of bowling like good length, half volley, full toss, bouncer, in-swing, out-swing etc. are possible; (iv) Different sizes of balls like practicing ball, international standard ball and tennis balls can be thrown effectively; and (v) The machine is portable and low cost.

Acknowledgements
The machine was fabricated and assembled by MTG, CMERI. The first author is thankful to the staff...
members of MTG, CMERI and Mr Dhara of M/s J S Engineering Works, Howrah, for their help and cooperation. The authors gratefully acknowledge the support and encouragement received from Director, CMERI.

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