

# Design of an Improved Cricket Ball Throwing Machine

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## ABSTRACT

This paper deals with design and development of an improved ball throwing machine for cricket batting practice. The bowling machine developed by CMERI, Durgapur, provides a very tangible and enjoyable way to improve batting performance of the cricketers. The improved ball throwing machine includes a pair of counter rotating, visco-elastic material bonded cast wheels. These ball ejecting wheels are mounted on a common base member which is supported on a three-axis tilting mechanism for precise adjustment of the delivery point of the ball with respect to three axes system i.e. roll, pitch and yaw axes, thereby controls the line and length of the ball precisely. Micro-controller based electronic controls are provided for controlling the speed of rotation of the each wheel. This adjustment of relative rotational speeds and plane of rotation of the wheels afford different kinds of bowling.

Keywords: Cricket, Ball throwing, Machine, design

## 1. Introduction

Today cricket is one of the most popular game in India and abroad. So it is felt that modern technology can be utilized to develop a cricket ball throwing machine with variable speed, swing and spin for the benefit of practicing batsman. The cricket ball throwing machine is to provide accurate and consistent batting practice for players of all standards like professional cricketers, amateur cricketers and club level cricketers. It is very much useful to the professional cricketers who can use it as part of their regular practice for fine-tuning of batting without necessity of bowler. It will be of much use at school, club and junior level where the standards of bowling are less consistent.

The literature and market survey reveals that there are number of ball throwing devices in abroad which generally fall into following categories: i) pneumatically operated machine [1-3], ii) spring actuated machine [4-6] and iii) one or multiple rotating wheel machine [7-9]. However ball throwing machine mentioned above are characterized by a number of disadvantages and limitations. The throwing machines of pneumatic type are great in volume, high in manufacturing cost and not portable. Second type of ball throwing machines uses a striking or throwing mechanism consisting of either spring or elastic to project the ball. In this arrangement difficulty is encountered in designing a suitable controllable deflection mechanism. Also, complications and inconveniences arise in providing a suitable feed mechanism since the ejecting mechanism must be accurately synchronized with the feed of the balls. Moreover these devices provide only limited directional control of the thrown ball and don't apply rotation to the ball as it is released. They are thus incapable of fully simulating the flight characteristics of a pitched ball. Third types of throwing machines utilize rotary wheels, which include a pneumatic tire mounted on a rim that is supported on a rotary shaft. Rotary wheels of the pneumatic tire type are characterized by a number of limitations. Principles among these are the requirement to maintain proper inflation pressure in order to insure consistent ball gripping action, the frequency of wheel balancing to prevent 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 diameters and therefore a separate type of designed device is required for each different diameter balls. Therefore, there is a need for an improved ball throwing machine that is capable of throwing a ball accurately and adjustably to a specific, predetermined location simulating the flight characteristics of a pitched ball. The objective of this work is to design and developed an improved machine, which is adjustable to throw different sizes cricket balls at various speeds in predetermined line and length.

## 2. Description of an Improved Cricket Ball Throwing Machine

### 2.1 Mechanical system of the machine

The improved cricket ball throwing machine (patent filed), designed and developed by CMERI, Durgapur, consists of major sub-assemblies like tripod cum tri-axial precise tilting mechanism, wheel and motor holding cum sliding arrangement etc. In the cricket ball throwing machine (as shown in fig. 1) of the present work, the main mechanism which has been used is based on pair of counter rotating rubber bonded ball ejecting wheels (01) along with above mentioned subsystems. This machine includes a base member with fork like ends. Each fork carries a wheel and motor holding cum sliding arrangement, which has a slider block. Each wheel is supported on slider block through bearing and each motor is fixed to the block by screw. The motor shaft is keyed to the wheel and locked by locking screw from the top, thus preventing the ejection of wheel at high speed of rotation. Each of the wheels preferably 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 in said body, extending circumferentially around the perimeter of the wheel for receiving a ball and for channeling the trajectory of the ball when the wheel rotates. On either side of the concave cross-section, filleted edges are defined in the body where the visco-elastic body is substantially thicker as measured from rim. Various types of materials may be employed for the visco-elastic body. In accordance with this work, the visco-elastic body is formed of synthetic rubber capable of providing a resilience with range of about 5D to 12D Durometer.

Tripod cum tri-axial precise tilting mechanism is used to hold the base member and to precisely adjust the required position of the delivery point of the ball with respect to three axes system i.e. roll axis, pitch axis and yaw axis to achieve a certain trajectory of the ball such that the ball pitches almost at same position relative to the batsman. The tripod cum tri-axial precise tilting mechanism has three indexer namely, Roll Axis Indexer (03), Pitch Axis Indexer (02) and Yaw Axis Indexer (04) integrated with a tripod casing (05).

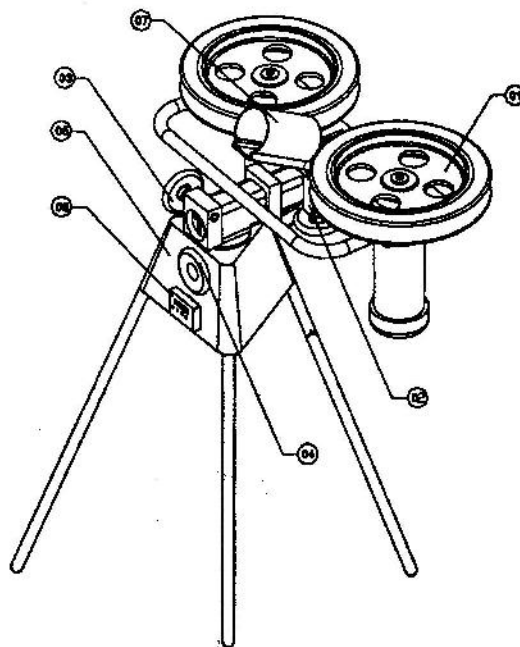


Fig. 1 Schematic view of ball throwing machine

Pitch Axis Indexer is used to control the length of the bowling. Pitching is the rotation of the top platform, over which the base member is fixed, about the pitch axis. By controlling this, the length of the bowling can be varied from bouncer to yorker, according to the will of the batsman. The precision and reproducibility of ball pitching distance that is required for effective batting practice is achieved by setting

precisely the rotation of worm and worm wheel for pitch which is attached with top platform of the Pitch Axis Indexer and fixed with cantilever type shaft portion of the Roll Axis Indexer. Roll Axis Indexer controls the axis of spin of the ball during spin bowling. The Roll Axis Indexer is directly placed on the top of the Yaw Axis Indexer. Yaw Axis Indexer is used to control the line of the bowling. For yaw, a worm wheel meshes with a worm inside the tripod casing.

The rack is fixed to the slider block with the help of screw. The pinion rotates inside a bush fitted in a casing and screwed to the base member such that it, meshes with the rack. The rack and pinion mechanism is used to control the gap between the two wheels for throwing balls of different diameters.

The ball is guided on a ball delivery chute (07) attached to the base member until it touches the curved surfaces of the wheels rotated in opposite direction. The ball passes through the gap that is less than the ball diameter and thereafter ejected tangentially forward. As the ball passes through the gap between the two wheels, the rubber material gets compressed. The concave surface provides a better contact and fillet edges provide a finger like grip on either side of its surface. The finger like gripping action of the fillet edges helps in controlling the trajectory of the ball.

## 2.2 Drives and control system of the machine

The drive motors are electric type, preferably PMDC in order to adjust the wide range of rotational speed of each wheel independently of the other. The speed and direction of the ball mainly depends 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 changes of speed of the motors are provided by varying analog voltages to the input of the motor controllers. The varying analog voltages are generated through micro-controller (89C51) an associated peripherals. The flowchart of the control scheme is shown in Fig. 2. By controlling the relative speeds of the counter rotating wheels that a twist can be imparted to ejecting ball. Simultaneously by changing the angle about the roll axes of rotation about roll axis that the twist imparted to the ejected ball can cause it not only to drop but to curve to the left or right as well.

## 3. Experimental Results

An experimental prototype of the cricket ball throwing machine has been developed. This was tested in the laboratory for measuring its bowling speed as well as the swing and spin characteristics. 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. To control the length of the bowling the tilting platform is inclined with respect to pitch axis by means of pitch axis indexer. By using yaw axis indexer the line of the ball is controlled. Inward or outward sliding of the motor-wheel mounted slider blocks with the help of rack-pinion mechanism will enable the throwing machine to accommodate balls of different diameters. In case of swing of the ball, a differential speed is maintained between the two wheels. To generate spin, a differential speed is maintained between the wheels as well as tilting platform is either inclined towards the left or right by means of roll axis indexer, according to the kind of the spin required. In the present experiment, Sports Radar 3500 measures the speed of the ball. Maximum speed of the ball obtained during experiment was 152 Km/hr.

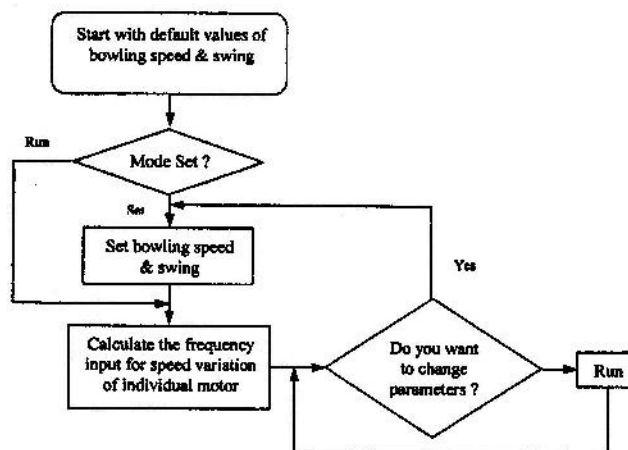


Fig. 2 : Flowchart of the Control Scheme

#### 4. Conclusions

The inventive step of the developed system rests in designing and developing tripod cum tri-axial precise tilting mechanism, special kind of ball ejecting wheel, wheel and motor holding cum sliding arrangement provided to change the gap between wheels and throw balls of different diameter, (beside the cricket ball), within the limit of the present specification.

The main advantages of the developed ball throwing machine are:

1. The bowling speed is variable within a range of 70 km/hr to 152 km/hr.
2. It has greater mobility i.e. 3 axes of freedom system which helps the ball to be pitched at the right place and spin in the required direction.
3. Different varieties of balls including in-swing, out-swing, leg spin, off spin is possible.
4. Different sizes of balls like international standard men's cricket ball s, women's cricket ball, tennis ball and like can be thrown effectively.
5. The machine is compact, efficient and economic.

In future scope of work, embedded technology based fully automatic control system will be introduced where information will be fed to the control system in terms of bowling speed and amount of swing.

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