

TO DEVELOP AN AUTOMATED CRICKET BALL FEEDER MACHINE WITH STOP-GO MECHANISM AND THREWAY FEEDING SYSTEM

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Abstract - Cricket is a highly popular sport that holds significant dominance. Within cricket training centers, there is use of expensive cricket ball throwing machines, some of which require manual operation for certain functions. To create an efficient and affordable solution, it has embarked on the development of a fully automated cricket ball throwing machine. It has incorporated a ball positioning mechanism to facilitate the delivery of different types, along with a stop-go mechanism and a three-way ball feeding system. With the help of Software analysis results and practical testing the ball positioning mechanism is instrumental in achieving diverse ball positions as they enter the ball throwing mechanism.

Key Words: Cricket, Automated, cost effective, Design, Stop-Mechanism, Ball feeding machine.

1. INTRODUCTION

Cricket is a popular sport which is played by many countries worldwide [1]. The sport of cricket requires dedication, integrity, and finesse. Along with years of practice, it also demands passion and devotion. Cricket involves batsmen and bowlers along with fielders. Bowling in cricket includes bowlers bowling at different lengths such as yorker length, good length, short length, and styles such as off spin, leg spin, inswing and outswing [1]. Bowl feeder acts as a cricket ball source for the batsman. Bowl feeders are used especially in net practices. A ball feeder is portable and used indoor as well as outdoor training. As cricket is one of the most famous sports in the world, a lot of people worldwide are interested in taking lessons. Hence ball feeders help such people in improving their game. Currently there are ball feeders which deliver only one kind of cricket ball to the batsman and are quite expensive. In addition to that the ball has to be released manually by the trainer in intervals. The ball feeders which are currently in the market are primitive and expensive too. These ball feeders deliver single type of balls without any ball positioning variation. Here an attempt is made to design and develop the ball feeder and positioning machine. The goal is to develop an efficient and affordable automated cricket ball feeder machine. The machine will deliver different types of balls such as leather balls, hard tennis balls as well as wobble balls. The machine also incorporates a stop-go mechanism and a ball feeding system. The feeder can store 18 cricket balls in total. Solenoid valves

are used to carry out the stop-go mechanism [2]. The Stop-Go mechanism will allow delivery of one ball at a time [2]. The ball positioning mechanism plays a crucial role in achieving diverse ball positions as they enter the ball throwing machine [3], [4]. The ball positioning helps in the achieving of different types of cricket ball deliveries. The ball positioning can be obtained by analyzing and changing the ball seam angle [3]. Guide rods are provided maintaining the ball seam position. The ball feeder is designed to obtain accuracy and precision while delivering the cricket ball. To put it in a nutshell this has developed a ball feeder capable of holding different types of balls and achieving the required ball positions for various ball deliveries using Stainless steel [5], [6]. The experiment's innovative approach will help in enhancing batting practice, in the hope of revolutionizing cricket training and producing elite cricketers.

2. MATERIALS AND METHODS

The purpose of this section is to outline the design considerations used in development of the cricket ball feeder, positioning mechanism and circuit for ball release mechanism. Factors considered during design process:

- Feeders should be able to hold different types of balls. Ball holders should be designed specifically for each ball type.
- Grooved balls are used to achieve right and left swing so the holder should be able to accommodate the grooved ball.
- Ball positioning mechanism should be designed for grooved balls.
- Circuit for ball release mechanism.

2.1 MODELING

Based on the purpose of the ball feeder each section of the ball feeder is designed and modeling is done. For 3D modeling of the feeder the software Autodesk Fusion 360 is used.

A. Ball Holder: The ball feeder is designed to accommodate three different types of balls used for cricket practice. Each ball holder section is designed to hold a specific ball type. The ball holder section is designed in such a way that it can accommodate 6 balls at a time. The following parameters considered in the design of ball holder are diameter of the

ball, position of the grooves on grooved ball and weight of the ball.

B. Ball Feeder: The ball feeder is designed to accommodate three different types of cricket balls, including leather and tennis balls, as well as grooved balls. The three ball holders, their alignment, and the structural design of the overall feeder, ensuring stability and the ability to withstand the weight of 18 balls are considered while designing the feeder.

- a. Holder Configuration for Grooved Balls
- b. Holder Configuration for Leather and Tennis Balls

In the following figure the final 3D design of the ball feeder along with it all three-ball holder section (without ball positioning rods) is shown:

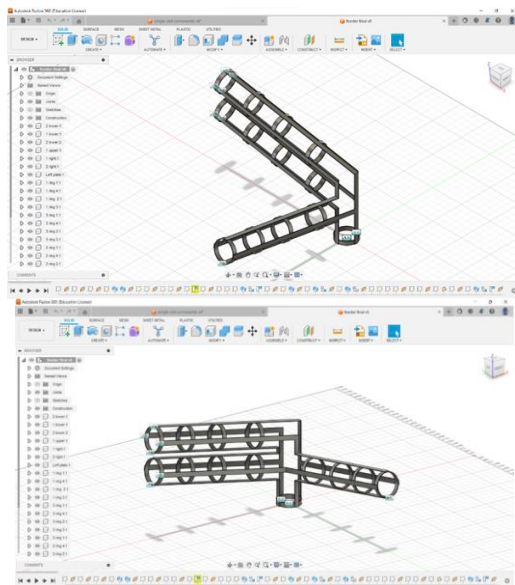


Fig -1: 3D design of the ball feeder

C. Ball positioning rods: The ball position mechanism is crucial for holder design, as it aligns the grooves of grooved balls for ball throw and swing. Guiding rods are used to position the grooved balls, fitting perfectly in the 1st and 3rd grooves. Two holders have opposing guiding rod directions for achieving right and left swings, while the third holder lacks such a mechanism, as the ball's position doesn't affect bowling variations.

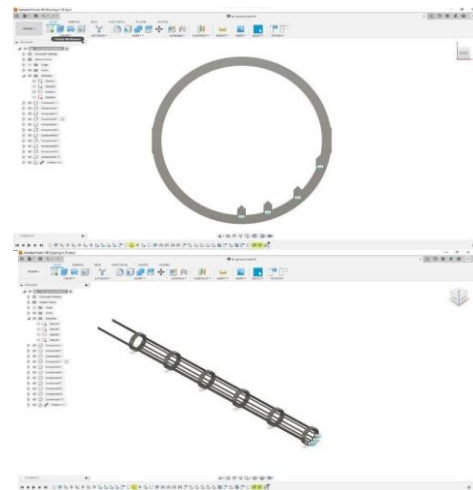


Fig -2: (a) Design of ball positioning rods; (b) placement of ball positioning rods

Design parameters for the ball positioning rods:

- Diameter of ball: 75mm
- Circumference of rings: $2 \times 3.14 \times 40 = 251.2\text{mm}$
- Grooves width and depth :2mm
- No. of grooves: 4
- Distance between two adjacent grooves: 6mm.
- Maximum number of balls in each holder: 6
- Length of holder from point of ball insertion release mechanism: $6 \times 75 = 450\text{mm}$
- Tolerance of 70 mm to accommodate the space to attach a solenoid actuator.
- Therefore, total length of holder = 520mm

D: Working of ball feeder

The three-way ball feeding mechanism is ingeniously designed to handle up to 18 balls at once, making it highly efficient for cricket practice sessions. Within this mechanism, each ball is individually slid into separate hoppers, and notably, two of these hoppers are equipped with specialized guiding rods. These guiding rods play a crucial role in precisely positioning the balls, ensuring that their slots align perfectly with the rods. As the balls are guided into their desired orientations, a stop-go mechanism comes into action. This mechanism also has programmable actuators, giving us complete control over the entire process of stopping and releasing the balls with exceptional accuracy.

3. CONTROL SYSTEM

The ball release mechanism is part of the ball feeder which is responsible for proper release of balls from their holders as required. Main function of this mechanism is to ensure the following objectives:

1. The ball is released based on the bowling type selected.
2. Ball is released from only one feeder.

3. Only one ball is released at a time.

Ball release mechanism is placed on the support rings of the ball holder. The position of the solenoid valve of the ball release mechanism is decided based on the total length required to accommodate 6 balls.

Following are the components used in the circuit of ball release mechanism:

- a. Arduino uno R3 – 1
- b. 12 V relay modules- 3
- c. 12 V battery- 1
- d. 12V solenoid valves- 3
- e. push buttons-3
- f. zero PCB

Stroke length of solenoid actuator: 25mm

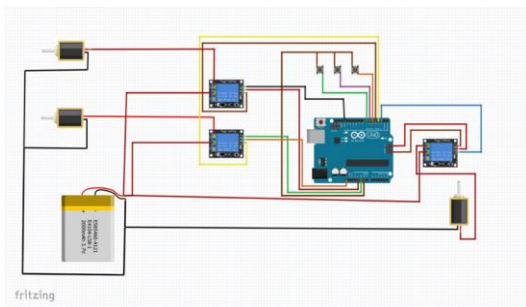


Fig -3: Circuit design of ball release mechanism

3.1 WORKING OF THE CIRCUIT:

Relay modules and the Arduino must both have a battery connected to get the proper power input. Push buttons should be connected to the Arduino's digital input pins. Relay module pins on the Arduino should be connected. To the relay modules, connect the 12V solenoids. To make these connections, use the corresponding wires. The push buttons are linked to the digital input pins on the Arduino so that the user can determine how the mechanism works. The Arduino UNO should be programmed with the proper code. The logic for reading input from the pushbuttons and controlling the relay modules appropriately should be included in the code. The push button input is read by the Arduino, which then uses the button presses to calculate the intended action. The Arduino activates the corresponding relay module by setting its output pin to HIGH when the proper push button is pressed. The solenoid valve is turned on when the current from the 12 V battery passes through the closed internal switch of the active relay module. According to its design, the solenoid valve opens or closes, permitting or restricting the movement of the ball by enabling or disabling the stop-go action of the mechanism. The Arduino switches the output pin of the associated relay module to LOW when the required operation is finished. The solenoid valve's current flow is stopped when the relay module's internal switch opens, bringing the mechanism to an end. By using the Arduino to activate and deactivate the relay modules, the solenoid stop-go mechanism carries out the desired stop and go actions in response to user input via the push buttons. The solenoid valves and relay modules receive power from the 12V battery, which enables the mechanism to operate as intended.

4. RESULT AND DISCUSSION

4.1 STRUCTURAL ANALYSIS OF THE MODEL

The design proposed is tested by applying required boundary conditions in analysis software namely Ansys. The minimum safety factor (per body) of the ball feeder is 2.643 and the maximum safety factor (per body) of the ball feeder is 15.

Material: Stainless steel

Density: 8E-06 kg/mm3

Young's modulus: 193000 MPa

Poisson's ratio: 0.3

Yield strength: 250 MPa.

Ultimate tensile strength: 540 MPa.

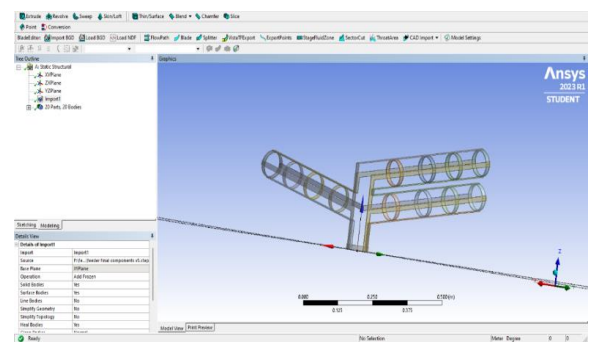


Fig -4: Geometry of feeder

Force on each holder:

Force magnitude: 40 N.

X direction: 0 N

Y direction: 0 N

Z direction: -40 N

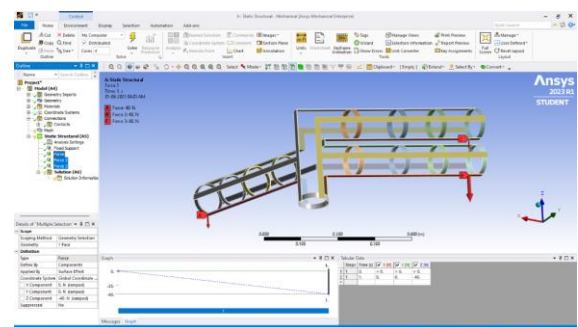
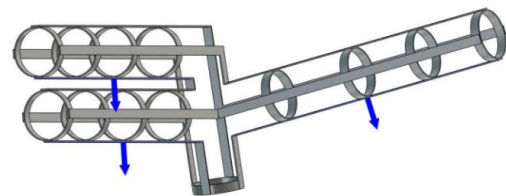


Fig-5: Forces on Feeder

Von Mises Stress:

The minimum Von Mises stress of the ball feeder is 9.604E-06 MPa and the maximum Von Mises stress of the ball feeder is 94.58 MPa.

Von Mises [MPa] 0 94.58

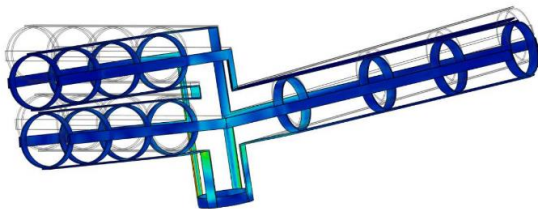


Fig -6: Von Mises stress- feeder

First principal stress:

The minimum first principal stress of the ball feeder is -17.45 MPa and the maximum first principal stress of the ball feeder is 90.79 MPa.

1st Principal [MPa] -17.45 90.79

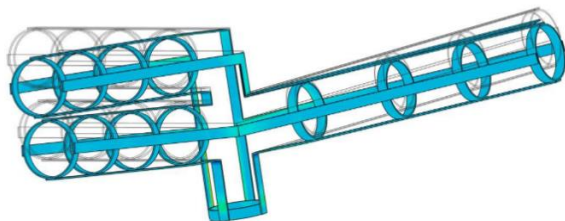


Fig -7: 1st principal stress- feeder

Total Deformation:

The minimum total deformation of the ball feeder is zero and the maximum total deformation of the ball feeder is 6.513 mm.

Total [mm] 0 6.513

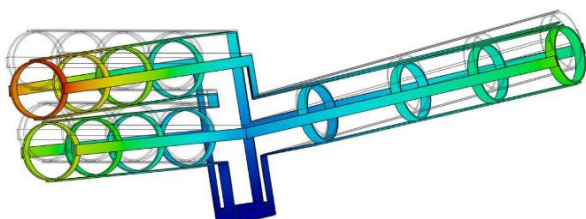


Fig -8: Deformation of feeder

4.2 ACCURACY OF ALIGNMENT OF BALL

During physical testing when balls were put into the feeder and aligned and with help of actuator mechanism, it was noticed that when balls are manually slid into the feeder by hand, the alignment accuracy reaches approximately 84% per 50 iterations. On the other hand, when balls are pre-fed into the feeder and subsequently controlled by the actuator mechanism, the accuracy increases to around 88%.

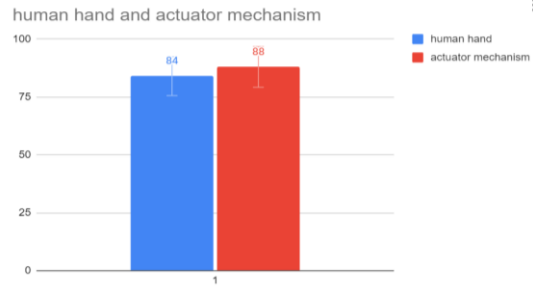


Chart -1: Graph shows data of human and automated system accuracy.

4.3 BALL RELEASE TIME

As mentioned previously, the ball release mechanism governs the controlled release of the ball. To ensure a smooth release, the time of retraction of the actuator needed to be determined. The following data illustrates the alignment accuracy of the ball for various time intervals of actuator retraction over 50 iterations. As evident from the data, a release time of 0.3 seconds yields the highest level of accuracy, making it the preferred choice.

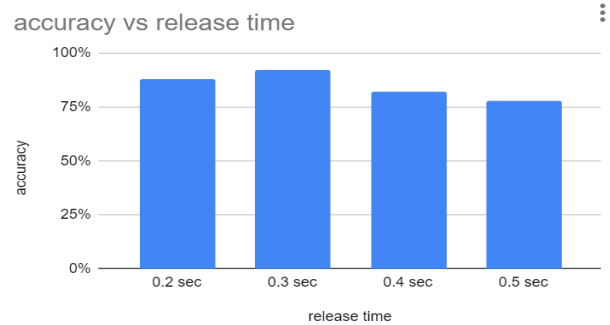


Chart -2: Graph shows data accuracy of ball for different release time.

5. MANUFACTURING OF THE BALL FEEDER

The ball Feeder was fabricated using argon gas welding for stainless steel. The ball positioning rods were fitted using epoxy adhesive, as welding the guide rods can interfere with the positioning of the ball while moving through the ball feeder. The solution brought up was to use epoxy glue adhesive.

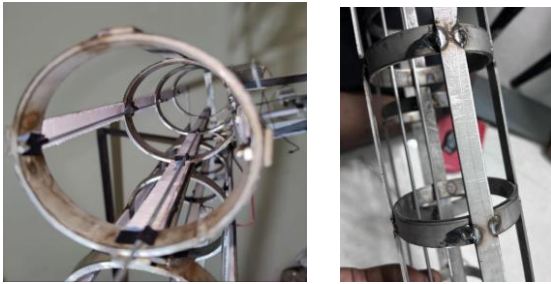


Fig -11: (a)Support rings;(b) Ball positioning rods

To achieve the desired height for the feeder, mild steel (MS) rods were utilized and welded to the feeder. MIG welding was employed for this process, utilizing stainless steel (SS) rods as filler material. The MS rods served as a sturdy support structure for the feeder.



Fig -9: a) Ball feeder with stand (b) Ball feeder

Three solenoids will be placed in 3 holders of the feeder, and it will release the ball based on batsman requirements. The actual circuit constructed based on the circuit design is as follows:

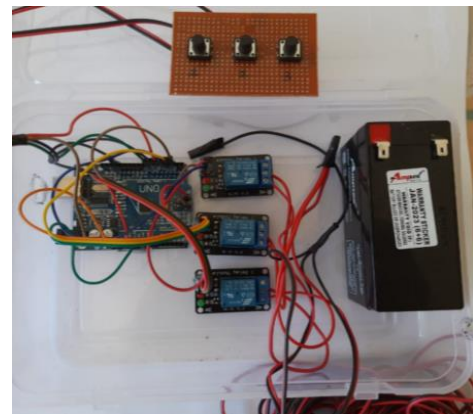


Fig -10: Release mechanism circuit

6. CONCLUSION

- a. The 3-way ball feeder has been skillfully engineered to accommodate a total of 18 balls, comprising 12 ribbed balls equipped with specialized slots for precise positioning. These strategically placed slots facilitate various ball movements, such as inswing and outswing. Furthermore, the feeder includes slots to accommodate both leather balls and tennis balls.
- b. The integration of circuits within the system ensures efficient control over the ball release, allowing for precise timing as desired. In summary, the project's objectives have been successfully achieved through the development and implementation of this mechanism. It enables diverse ball positions and a continuous stream of 18 deliveries, which can be customized for inswing, outswing, or straight deliveries. This remarkable accomplishment provides batters with a versatile and effective training tool to elevate their batting techniques and overall performance.
- c. This advanced feeding system offers a continuous and streamlined flow of cricket balls, providing an ideal training tool for batters to refine their techniques and enhance their overall performance on the field. Its efficiency and precision make it an indispensable asset in cricket training setups, helping players sharpen their skills and face various challenging ball orientations with confidence.

7. REFERENCES

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