Design And Fabrication Of Portable Shuttlecock And Tennis Ball Shooting (Training) Machine

Dr. K. Deepandurai, S. Abishek, N. Devanandh, S. Dineshkumar

Abstract: This paper deals about the design and fabrication of portable badminton and tennis ball shooting machine. There is no machine for a training of shuttlecock and tennis. This project helps to train the players for both shuttlecock and tennis by using a single machine. The primary objective of the project is to give proper oscillating movement to launch the shuttlecock or tennis ball to cover all types of shot. In this project, two high speed Direct Current (DC) motors has been used. Two wheels are connected to the motors individually. The motor setup is connected with a spring to absorb the vibrations. The wheels adjust their space as according to the diameter of the ball. The tennis ball or shuttlecock is fed one by one with the help of gun type DC actuator that is attached to separate dispenser for shuttlecock and tennis ball. The entire setup is mounted on a frame which is connected to a slow speed motor. It is used for the oscillatory movement of a machine. The electrical parts are powered by 12V battery and are controlled with the help of Arduino. The oscillatory frame is set to time limit of three seconds to rotate from left end to the right end. The gun type actuators are programmed to throw the balls one by one with a time limit of one to three seconds. The player can train all types of shots covering all areas of the court with the help of the training machine, helping the low-level academies to train their players.

Index Terms: Shuttlecock, Tennis ball shooting machine, DC motor, Battery, Gear, Actuator, arduino, Relay.

1. INTRODUCTION

Badminton and tennis are two major sports in the world. Badminton is played with shuttlecock and tennis is played with ball. In order to train during training, two players are needed which is not possible at most times. In these situations, the players need a machine to train in these situations. The presently available machine is too costly which an average institute or people cannot buy. The number of suppliers in this market is also less compared to other sports, which drives us to find a solution for this problem to develop these sports locally. The main target of the product are those peoples, who needs a training kit at low cost. The oscillatory motion in the presently available machine is not that effective. The project focuses to fabricate a machine which provide a training machine for both tennis and badminton players and to develop good oscillatory motion to throw the ball or shuttlecock.

2. COMPONENTS

2.1 DC Motor

A DC motor is a rotary electrical machine that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor. DC motor works on the principle of Fleming left hand rule. Small DC motors are used in tools, toys, and appliances.

- *Dr. K. Deepandurai is Assistant Professor of mechanical engineering in Kongu Engineering College, TamilNadu, India, PH-9994543214. E-mail: deepan.mech@kongu.edu*
- *S. Abishek is currently pursuing bachelor degree program in mechanical engineering in Kongu Engineering College, TamilNadu, PH-7339230484. E-mail: abishek199906@gmail.com*
- *N. Devanandh is currently pursuing bachelor degree program in mechanical engineering in Kongu Engineering College, TamilNadu, PH-9600273583. E-mail: ndevanandhss@gmail.com*
- *S. Dineshkumar is currently pursuing bachelor degree program in mechanical engineering in Kongu Engineering College, TamilNadu, PH-7339440091. E-mail: dineshkumar.sakthinalini@gmail.com*

Fig.1 *DC Motor*

2.2 Arduino Board

The supply voltage of 230V is step down by using a transformer to 12V which is fed to the circuit. Then the 12V AC is converted to 12V DC using regulator and diode. The 12V DC fed to relay unit which is connected to Arduino board, programmed to rotate the oscillatory frame to give the horizontal motion for the player as shown in the figure 6.4. Two switches are connected to the board which switches between stoppers of ball and shuttlecock separately. A battery is used to give supply separately to motor and stopper.

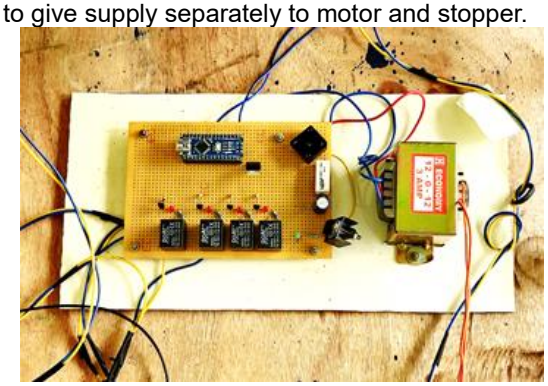

Fig. 2 *Arduino*

2.3 Stopper

The gun type DC Actuator is used as a stopper. An actuator is a component of a machine which is responsible for controlling and moving a mechanism. It is powered by 12v battery with the help of relay unit. Arduino and relay unit is used to actuate the actuator ensuring that only one ball is allowed to fed to the wheels.

Fig. 3 *Gun Type DC Actuator*

3. DESIGN AND CALULATIONS

3.1 Design

The design of shuttlecock and tennis ball shooting machine is shown in fig. 4. This design is done with the help of CATIA V5.

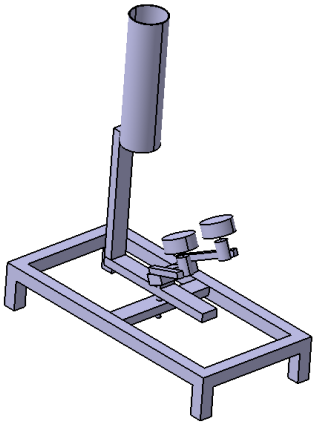

Fig. 4 *Isometric view*

3.2 Design Calculations

- Torque Generated by the Motor

For 12V DC motor,

P(rotational) = 48 watt

= 0.0065 HP

P(rotational) = M x ω (1)

Where, ω = Angular velocity

M = Torque

Angular velocity,

$$\omega = \frac{2 \times \pi \times N}{60} \quad (2)$$

12V DC motor has 2500 rpm.

$$\omega = \frac{2 \times \pi \times 2500}{60}$$

ω = 261.66 rad/sec

$$\text{Torque, } M = \frac{P_{(rotational)}}{\omega} \quad (3)$$

$$= \frac{48}{261.66}$$

M = 0.184 N-m

To get actual torque divide the torque by factor f,

$$M(actual) = \frac{M}{f} \quad (4)$$

$$= \frac{0.184}{0.0147}$$

M(actual) = 12.51 N-m

- Velocity Calculation for Shuttlecock

Distance,

$$L = \frac{(u^2 x \sin 2\theta)}{g} \quad (5)$$

Where,

L = Distance

u = Velocity of shuttlecock

θ = Angle of launch (30°)

Length,

L = 13 m

Now velocity,

$$u^2 = \frac{(13 \times 9.81)}{\sin 2(30°)}$$

Velocity, u = 12.13 m/s

- Torque Calculation for Shuttlecock

Torque,

T = m x g (6)

Mass,

m = 0.1 N

T = 0.1 x 9.81

- Velocity Calculation for Tennis Ball

Distance,

$$L = \frac{(u^2 x \sin 2\theta)}{g} \quad (7)$$

Length, L = 24 m

Now velocity,

$$u^2 = \frac{(24 \times 9.81)}{\sin 2(30°)}$$

= 271.86 m/s

Velocity, u = 16.48 m/s

- Torque Calculation for Tennis Ball

Torque,

T = m x g (8)

Mass of ball,

m = 0.5 N

T = 0.5 x 9.81

T = 4.905 N-m

Since, the required torque is well behind the motor torque 12V DC motor has been selected for this project.

4. PROPOSED SYSTEM

- Firstly, the ball or shuttlecock is loaded to their respective dispenser and start the wheel motor which will rotate in opposite direction
- The stopper button is pressed which is connected to the circuit to select either ball or shuttlecock the player need to train..
- The ball or shuttlecock will be fed to the wheels from the dispenser with the help of stopper which will make sure that the ball or shuttlecock are entering the wheel one by one.
- The oscillatory frame switch can be turned on if player needs the ball or shuttlecock to be thrown in different horizontal positions.
- The stopper switch can be reversed to switch between Tennis ball thrower and shuttlecock thrower.
- The supply to every electrical component is given through a transformer to step down the voltage from 230V to 12V.

Fig.5 *Pictorial view*

5. RESULTS

The project has been tested in the court yard and the results are noted. The test results of the fabricated model are given in form of table below.

TABLE 1
TEST RESULTS

Mode	Angle of Elevation (Degree)	Distance covered (metre)	Velocity (m/s)
Shuttlecock	30	10.3	5.1
Tennis Ball	30	8.4	3.1

Thus, the proposed design is successfully implemented in form of project. The oscillatory motion in the developed machine has been comparatively good. This project can be used effectively in small level academies where those academies cannot afford such costly machine for training their students. This machine can also be used for home purpose where people can train in their home. The wheel angle is fixed in this machine and it can be modified to adjustable one, which will improve the machine performance as well as the player training experience. This project can be effective for players and reduce the trainer's effort, fatigue and cost of training.

6. CONCLUSION

- Thus, the developed portable Tennis and shuttlecock training machine can be used effectively to throw the ball or shuttlecock up to a distance of 10.3 metres.
- The velocity of the shuttlecock thrown is 5.1 m/s and the velocity of the tennis ball thrown is of 3.1 m/s
- The angle of elevation used to throw ball and shuttlecock is 30˚ and it can be modified to adjustable one to improve the machine performance.
- The quality of the ball thrown in the fabricated machine is better than training with the trainer manually.
- The program interfaced with machine work flawless and gives accurate timing when the ball or shuttlecock is thrown.
- The developed machine is simple and can be used by anyone with the trainer's advice and it is also cost effective than any other presently available training machine.
- It can be used in small level training academies to train players at reduced cost and reduced trainer's effort and fatigue.

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