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Economical Bowling Machine with PWM controller

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Abstract: For several years, ball pitching systems have been used in sport preparation. The aim of this project is to create the cheapest ball pitching device ever, capable of automatically throwing balls at various appropriate adjustable speeds for cricket practice. Typically, balls are tossed from a platform that uses motors, but the user may also control the discs and swing. The batsmen will benefit from the bowling machine's assistance in mastering their abilities. Different bowling patterns can be created by the machine. The unit is made up of two motors, one of which rotates clockwise and the other anticlockwise. The distance between the wheels should be moderately less than the diameter of the tossed ball. Between the two motors, a valve is mounted. The balls are inserted into the valve when the motor reaches the desired rpm. By frictionally grasping the ball between two spinning wheels, this machine transfers kinetic energy to the ball. The motor's rotational speed can be changed independently using an electronic regulator. The whole unit is placed on a height adjustable stand. Thus can be used for varying the length according to the requirements. The stand is placed perpendicular to the upper chassis. The report outlines all of the specification requirements for creating a professional cricket pitching machine, including technical and electronic aspects.

Keywords: Bowling Machine, Ball feeding machine, multiple release point, Autofeeder.

I. INTRODUCTION

A bowling machine in cricket is a system that allows a batsman to train (usually in the nets) and hone particular skills by repeating the length, line, and pace of the ball being bowled. It can also be used when no one is available to bowl, or when no one of the same type or quality is available. There are many different types of bowling machines available to cricket coaches, each with its own unique means of delivering the necessary delivery. However, most allow for remote control, allowing the coach to be closer to the batsman while the stroke is played. The machine's main assembly is made up of two large wheels of solid or pneumatic rubber tires, each with its own motor. These were placed in a frame such that the wheels are parallel to each other.

The unit can pass in a wide variety of directions owing to the ball joint. The entire structure is mounted on a durable height-adjustable stand, with the wheels set at about the same height as a normal bowler might release the ball. The motors typically run in opposite directions and are driven by a car battery. A controller allows the speed of and wheel to be varied, enabling the system to be slowed down for less skilled batsmen or swing or spin bowling to be replicated while the motors are not working at the same speed. Any ball of roughly the right size and weight, such as regular cricket balls or tennis balls, can fit in these devices.

II. HARDWARE DESIGN

The machine can be divided into three major parts namely the upper chassis or the bowling unit, autofeeder unit, and the lower chassis or the lower stand.

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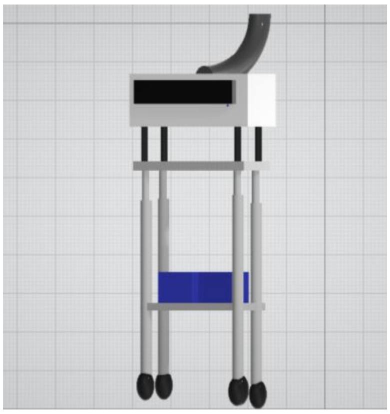

Fig.1. CAD model of bowling machine

The above figure shows the CAD model of the bowling unit. Both the bowling unit and the autofeeder unit has electrical components and circuit connections whereas the lower chassis or the lower stand contains only mechanical parts.

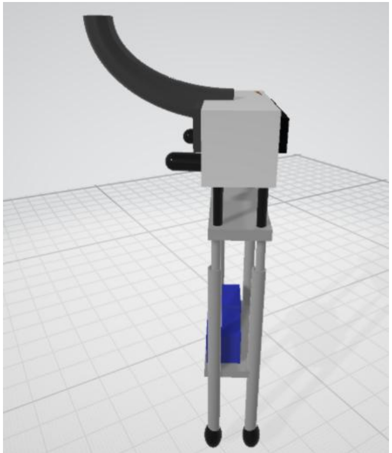

Fig.2. Rear view of CAD model

The above figure shows the Rear view of the bowling machine. The main components are DC motor, Lead acid battery, PWM controller, Arduino UNO, Wheel, Drawer slides, Gas springs and the Servo motor. The upper chassis is made of plywood to reduce weight and cost. The lower chassis is made of steel pipes.

A. DC MOTOR

Any rotary electrical motor that transforms direct current electrical energy into mechanical energy is referred to as a DC motor. The most popular forms depend on magnetic fields to generate forces. Almost all DC motors have an internal mechanism, either electromechanical or electronic, that changes the direction of current in a part of the motor on a regular basis. Since they could be operated by existing direct-current lighting power delivery systems, DC motors became the first type of motor to become widely adopted.

Fig.3. 24V DC Motor

The above figure shows the representation of the 150W DC Motor. It has 9 tooth sprocket with loaded RPM of 2600 to 3000. It is 70% efficient and weighs around 1.4 Kg. It has a rated current of 14.3 A and rated voltage of 24V.

The speed of a DC motor can be varied over a wide range by varying the supply voltage or adjusting the current intensity in the field windings. Tools, toys, and gadgets all use small DC motors. The universal motor is a lightweight brushed motor that can run on direct current and is used in compact power tools and appliances. Larger DC motors are currently used in electric car propulsion, elevator and hoist drives, and steel rolling mill drives. With the invention of power electronics, it is now possible to replace DC motors with AC motors in a variety of applications.

Brushed DC motors are the most widely used at the moment because they are easy to miniaturize and have good rotational control as well as high performance. Brushless DC motors, on the other hand, have a longer life, are easier to maintain, and produce less noise because they do not have brushes or commutators, which are disadvantages of brushed DC motors. The DC motor used for this project has a specification of 24V, 150W.

B. PWM CONTROLLER

Pulse width modulation (PWM), is a process of reducing the power produced by an electrical signal, by cutting it into discrete parts. The mean value of both current and voltage fed into the load is operated by changing the switch between supply and load with faster rate. The higher the switch time is on, the higher the power delivered to the load. PWM is particularly well suited for running inertial loads like motors, which are less affected by discrete switching due to their inertia. The PWM switching frequency must be high enough to avoid affecting the load, which means the waveform seen by the load must be as smooth as possible.

Depending on the load and application, the rate (or frequency) at which the power supply must switch can vary greatly. An electric stove, for example, must switch several times per minute; a lamp dimmer must switch 120 Hz; a motor drive must switch between a few kilohertz (kHz) and tens of kHz; and audio amplifiers and computer power supplies must switch well into the tens or hundreds of kHz.

Fig.4. PWM controller

The above figure shows the PWM Motor Speed controller with 20A current regulator. The product name is Techtonics DC 10-60V 20A 1200W Motor Speed control.

The key benefit of PWM is that it has a very low power loss in the switching units. There is almost no current when a switch is turned off, and there is almost no voltage drop around the switch when it is turned on and power is transferred to the load. Since power loss is the product of voltage and current, it is similar to zero in both cases.

There are various approaches to control the speed of DC engines yet one straightforward and simple path is to utilize Pulse Width Modulation. They use digital signals to regulate power applications.

C. SERVO MOTOR

A servomotor is a rotary or linear actuator that can control angular or linear orientation, velocity, and acceleration with precision. It is made up of an appropriate motor and a position feedback sensor. It also necessitates a sophisticated controller, which is often a dedicated module designed especially for servomotors. Although the term servomotor is frequently used to refer to a motor suitable for use in a closed-loop control system, it is not a particular type of motor. Servomotors are used in robotics, CNC machinery, and automated processing, among other uses.

A servomotor is a closed-loop servomechanism that controls its motion and final position using position feedback. The direction commanded for the output shaft is represented by a signal (analogue or digital) that is fed into the power. To provide position and speed input, the motor is connected to a position encoder. Just the direction is evaluated in the most basic case. The calculated output position is compared to the command position, which is the controller's external feedback.

The simplest servomotors use a potentiometer for position sensing and bang-bang motor control; the motor still rotates at maximum speed (or is stopped). While this kind of servomotor is not often used in industrial motion control, it is the foundation for the simple and inexpensive servos used in radio-controlled versions.

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The speed of the output shaft is measured by optical rotary encoders, and the motor speed is regulated by a variable-speed drive in more advanced servomotors. Both of these improvements, when combined with a PID control algorithm, make the servomotor to reach its commanded location faster and more precisely, with less overshooting. The majority of modern servomotors are built around a dedicated controller module from the same company. Controllers can also be built around microcontrollers to save money in high-volume applications.

Fig.5. MG995 Servo motor

The above figure shows the Tower Pro MG995 servo motor with 180-degree rotation. They provide a torque of 10kg/cm with 4.8V~7.2V operating voltage.

D. LEAD ACID BATTERY

A lead acid battery is a type of battery that converts chemical energy into electrical energy using sponge lead and lead peroxide. Because of its higher cell voltage and lower cost, lead acid batteries are most widely found in power stations and substations. The lead acid battery's key components are the bottle and plates. The plates translate chemical energy into electrical energy, which is stored in the bottle. The lead acid battery's jar is made of glass, lead lined wood, ebonite, bituminous hard rubber, ceramic compounds, or molded plastics, and is seated at the top to prevent electrolyte discharge. There are four ribs at the bottom of the container, two of which protect the positive plate and the others the negative plate. The lead-acid cell plate comes in a variety of shapes and sizes, but they all have a grid composed of lead and the active material. The grid is essential for conducting electric current and evenly spreading it through the active material. The active substance will relax and fall out if the current is not spread evenly. The active material of a cell is the material that participates actively in a chemical reaction (absorption or evolution of electrical energy) during charging or discharging. The active ingredients in lead acid are Lead Peroxide, Sponge lead, Dilute Sulfuric Acid. Since the negative and positive active materials, lead peroxide and sponge rubber, have low mechanical strength, they can be used individually.

Fig.6. 12V Lead acid battery

The above figure shows the depiction of Lead Acid Battery. The battery used in the project is Exide (12V, 12A). Small sheets of non-conducting material, such as chemically treated Leadwood, porous rubbers, or glass fiber pads, are placed between the positive and negative to insulate them from each other. On one line, separators are grooved vertically and flat on the other. The positive and negative terminals of a battery are related. The positive terminal, which has a top diameter of 17.5 mm, is significantly greater than the negative terminal, which has a diameter of 16 mm.

E. ARDUINO UNO

The Arduino Uno is an open-source microcontroller board designed by Arduino.cc and based on the Microchip ATmega328P microcontroller. The board has digital and analogue input/output (I/O) pins that can be used to connect to expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six of which are capable of PWM output), 6 analogue I/O pins, and is programmable via a type B USB cable using the Arduino IDE (Integrated Development Environment). It can be powered by a USB cable or an external 9-volt battery, with voltages ranging from 7 to 20 volts. It is similar to Arduino Nano. This board has all of the functionality needed to operate the controller and can be directly attached to a device via USB cable. The code is transferred to the controller using IDE (Integrated Development

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Environment) software, which was designed specifically for Arduino programming. While IDE is compatible with Windows, MAC, and Linux, Windows is the preferred operating system. The IDE makes use of programming languages such as C and C++. In addition to USB, the board can be powered by a battery or an AC to DC adapter. In terms of use and features, Arduino Uno boards are very similar to other Arduino family boards; however, Uno boards do not have an FTDI USB to Serial driver chip. There are some Uno boards available, but the Arduino Nano V3 and Arduino Uno are the most official models, both of which have an Atmega328 8-bit AVR Atmel microcontroller with 32KB of RAM.

Fig.7. Arduino UNO

The above figure shows the pictorial representation of Arduino UNO. It has a flash memory of 32KB and Clock speed of 16MHz.

III. WORKING

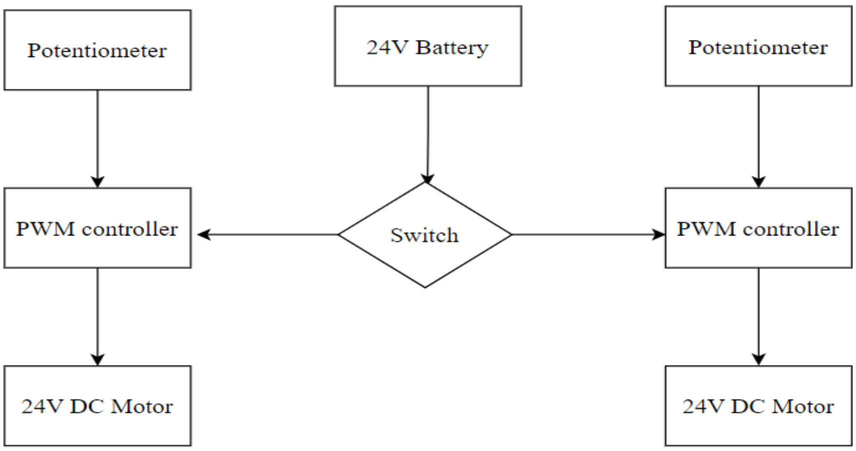

Fig.8. Block diagram of bowling unit

As the above figure shows the battery is connected with the switch. For the proposed project two 12V batteries are connected in series thus providing 24V power. The switch controls the power supply to the two PWM controllers. The two PWM controllers are connected separately to the motor. The potentiometer is connected with the PWM controller to control the speed of the two motors separately. The two dc motors are kept inside the upper chassis. Two wheels are attached to the shaft of the two dc motors. The motors are placed in the plywood or the inner chassis. The sliders are attached to the both sides of the inner chassis. The sliders are then attached to the inside of the outer chassis. The autofeeder is connected behind the motors so that it can deliver the ball inbetween the two motors. The below image shows the connections inside the unit.

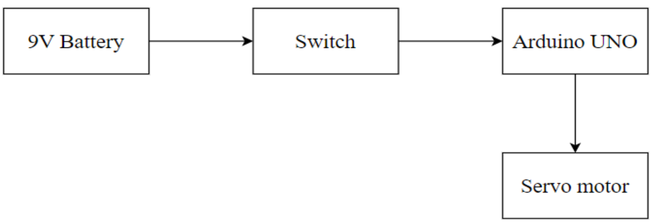

Fig.9. Block diagram of autofeeder unit

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The autofeeder consists of servo motor, which is connected to an arduino. The arduino is powered by a 9V battery which is controlled by a switch. The arduino program for the autofeeder is provided below.

A. ARDUINO PROGRAM

```
#include<Servo.h>
//Servo library
Servo servo_test;
//initialize a servo object for the connected servo
int angle = 0;
// setting the initial angle of the servo motor at 0 degree
void setup ()
{
Servo_test.attach(9);
//attach the signal pin of servo to pin9 of arduino
}
void loop ()
//setting the motor in loop so it will run continuously
{
for (angle = 0;angle<180;angle+= 15)
//command to move from 0 – 180 degrees
{
Servo test.write(angle);
//command to rotate the servo to the specified angle
delay(15);
}
delay(100);
for (angle=180; angle>=1; angle-=5)
//command to move from 180 - 0 degrees
{
Servo_test.write(angle);
//command to rotate the servo to the specified angle
delay(5);
}
delay(200);
}
```

IV. RESULTS AND DISCUSSION

Fig.10. Rear view of the bowling machine

Fig.11. Top view of the bowling machine

The above figure shows the hardware output of the proposed project. The machine is tested for various heights and different lengths at different speeds. As the image depicts the ball is fed between the two motors from behind. As the ball passes through the motors it gains momentum and is pushed out with high speed.

Since two motors are controlled individually, we can operate the motors at different speeds. By varying the speed of the motors, different deliveries is obtained such as inswing. Outswing, stock, leg spin, off spin and straight balls. The speed of the motors is measured with tachometer. The following table shows the output of the bowling machine when operated at different speeds.

Table.1. Output of the bowling machine

Speed of left motor (rpm)	Speed of right motor (rpm)	Nature of delivery
1800	1800	Straight
1500	1500	Straight
2700	2700	Straight
2500	1800	Outswing
1800	1100	Outswing
1900	2600	Inswing
800	2000	Inswing

Since the main objective of the project is to reduce the cost of the bowling machine. By being very cautious in selecting the components and the process and also not compensating on the quality the total cost of the project at the end is Rs. 14000 which is very less when compared to the bowling machines available in the market.

V. CONCLUSION

Current cricket bowling machines are extremely costly, so this cricket bowling machine was created with the aim of creating a low-cost (economic) and portable cricket bowling machine. For beginners, this project allows them to use a variety of bowling patterns such as parallel, outswing, inswing, off-break, and leg-break. This initiative can be implemented in academies, sports complexes, schools, and universities, as well as by individuals who cannot afford to purchase costly bowling machines.

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