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Design and development of solar powered, bluetooth controlled seed metering mechanism

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Abstract

A solar-powered, Bluetooth-controlled seed metering mechanism is developed to make the machines sustainable and easy to use. Using Bluetooth devices like smart phones reduces the cost of machines and gives a high yield. It replaces the fuel-powered seed metering mechanism, which has lots of environmental problems and labour costs. In a developed machine, the machine is powered by solar energy, which is stored in a battery. At the same time, the machine's motors are rotating using this power, and directions are controlled by Bluetooth devices like a smart phone. For the travel of the machine, we used two DC motors and direction control. The front wheels are connected to a bearing, and where the rear wheel movement is high or rotation is high, the front wheel rotates that side. For the metering mechanism, we used a metallic geared servo motor 360, which is controlled by an Arduino UNO using a Bluetooth module. Chickpea is metered using this machine and gave 83% field efficiency, 0.48 and 0.40 hac/hr theoretical and actual field capacity.

Keywords: Solar powered, bluetooth module, field efficiency Arduino UNO

Introduction

A solar-powered seed metering mechanism is used to distribute seeds of various sizes and shapes in the field. There is a cool new idea: using sunlight and Bluetooth to control the sowing of seeds. The system is powered by sunlight and hence does not require fuel to function [1]. Farmers can control anything from their smart phones using Bluetooth, allowing them to make changes without even being in the field. This machine is a collaboration of machine and wireless control of machine. In this machine, Arduino Uno is used as a microcontroller that controls the dc motor speed, direction, speed of the servo motor [2], and Bluetooth module. A Bluetooth module is used to connect the control of a machine to a smart phone using mobile apps like RC cars, Arduino cars, etc. Bluetooth can be easily available on any model or version of smart phone and is available to all farmers at present. This machine provides sustainable farming methods of metering the seeds using solar energy to measure and control the speed and direction of the machine [3]. A solar panel is used in front of the machine, which collects the photons and stores the electrons on a battery. The stored electrons are used to run the machine through a microcontroller and a Bluetooth module. This machine is very useful to the farmers to increase the productivity of crops while reducing the cost of farming using sustainable methods [5]. It uses solar energy, so no environmental pollution occurs using this machine, and it is eco-friendly for the environment and for farmers.

Materials and Methods

The design and fabrication of a solar-powered, Bluetooth-controlled seed metering mechanism required the following materials: solar panel, 12v battery, square iron rod, geared dc motor, servo motor 360, motor driver, Arduino Uno, jumper wire, Bluetooth module, wheels, bearing, shaft, nut & bolt, seed metering assembly, etc. Fabrication of the machine: various parts of the machine are fabricated, then welded or finally assembled one by one. The parts are - body frame, solar panel stand, wheels, supporting rod, axle with bearing attached, seed metering assembly (hopper, shaft, seed metering, seed groove, drop tube, and servo motor), front wheel with bearing on top, plate for keeping batteries and electronic components safe, etc., and all parts are welded and bolted to a suitable size. Electric circuits relate to various sensors, batteries, solar panels, dc motors, and bluetooth modules. For coding, we used the Arduino IDE software, in which code was written to control the dc motor using a Bluetooth-connected device in various directions (forward, backward, left, right, etc.) and to control the servo motor speed and direction.

The components of the machine are shown below

S. No.	Components	Description
1	Body-frame	This is the base of the machines on which different parts are assembled. Loads of the parts and seeds are transferred to the wheels via the body frame, which is important for the stability, load distribution, and assembly of various parts.
2	Solar panel	A 20-volt solar panel is used to charge the 12-volt, 7.1Ah battery. Which is bolted on a stand that is tilted at some angle and connected to the battery using a diode.
3	Battery	two 12-volt, 7.1 AH batteries are used in this machine to run the dc motors, servo motor, and 5-volt supply to the microcontroller (Arduino Uno).
4	Dc motor	Two dc motors are used in this machine, which are connected by chain and sprocket (alternate pulley and belt), which reduces the speed of the wheels and gives high torque, which is important for the machine while using in-field work.
5	Servo motor 360	It is used to rotate the shaft of the seed metering. By rotating the shaft, seeds are distributed into the field via the seed groove and drop tube.
6	Front and rear wheels	The front wheel is connected through the bearing to control the direction of travel of the machine. Rotating the machine in the left direction, in this condition, the smartphone commands come, the left dc motor stops, the right motor runs, and the front wheel automatically rotates to the left. Same for the right turn. Rear wheels are connected to the shaft and sprocket, which are powered by DC motors and transfer the load of the machine to the soil.
7	Chain and sprocket	It is used to transmit the motion from the DC motor to the wheel by reducing the speed and increasing the torque.
8	Arduino Uno	This is a microcontroller used to control the various functions of the machine-like direction and speed of the dc and servo motors by Bluetooth. It provides a pulse width modulation feature to control the speed of the DC motor.
9	Bluetooth module	This module is used to connect the machine's control to a smart phone using Bluetooth.
10	Motor driver	This component is used to supply an equal amount of voltage to dc motors as well as a 5-volt supply to the microcontroller (Arduino Uno), and the input power source is a battery.
11	Hopper and metering assembly	Hopper, which is used to keep the seeds and fall to the seed metering mechanism at a controlled rate, and then seed metering, seed grooves keep the seed and fall to the drop tube via a rotating shaft, rotated by a servo motor 360

Methodology

The different steps involved in assembling the parts for the machine are here: -

The project's assembly process includes of lots of essential parts, beginning with the fabrication of the base frames using square iron pipes measuring 120 cm in length and 80 cm in width. Various components and rods are welded, nutted, and bolted to this frame. A bearing-welded shaft with two "U"-shaped rods attached that allow continuous rotation of the wheels, is welded to the frame. The wheels have been fixed to this shaft to ensure synchronized its rotation. Further, a sprocket is welded to the inner portion of the shaft and connected to a DC motor via a chain, as was the case for the other rear wheel. The front wheel, which is intended to revolve freely, is connected to a shaft with its end welded to a rod that is attached to the bearing's outer surface. An iron rod is pushed and welded into the inner circle of the bearing,

as well as the machine's frame. A further square iron rod is welded to the front of the frame, which consists of a 40 cm stand and a 10 cm rod inclined at a 25–30-degree inclination to support a solar panel. Two parallel plates welded to the base of the framework support the battery. Another square iron rod is welded to the back of the frame to support the seed metering assembly, with precision-drilled holes for mounting nuts and bolts. The seed metering equipment received from the college, is mounted, and attached to a servo motor 360 to facilitate rotation of the seed metering and seed grooves. For the DC motor setup, two rods with plates have been welded to the extra rod which holds the seed metering assembly. The DC motor placed on this structure is linked to the rear wheel's sprocket via a chain. The Arduino Uno is programmed using IDE software, and the Bluetooth module is connected to the board through its correct pins. The motor driver and servo motor 360 have been connected to the Arduino Uno, according to in the code. The motor driver has been connected to the battery, with the positive and negative terminals exact matched. The Arduino obtains a 5-volt supply through jumper wires connected to Gnd to Gnd and +5V to Vin. Once powered on, the Bluetooth has a connection with an app which enables control of the DC motors and servo motor, including speed regulation.

Fig 1: Process flow of development of the mechanism

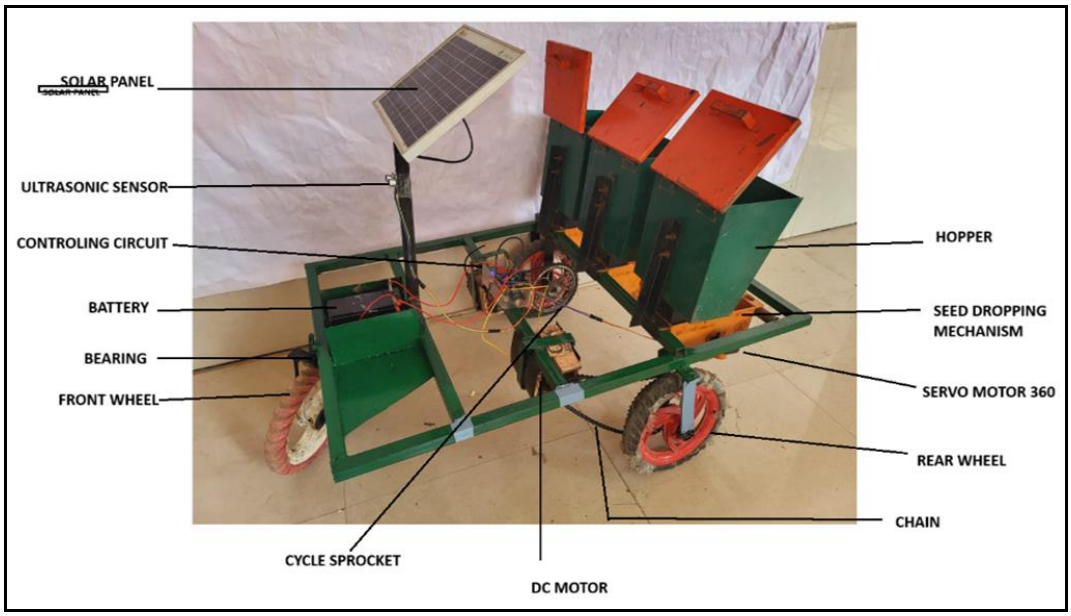

Fig 2: Label diagram of the machine developed

Fig 3: Back view of machine including seed metering mechanism

Working

This machine is controlled by Bluetooth devices; for this machine, we used a smartphone to control the machine's direction and speed, as well as a servo motor. Solar energy is stored in the battery through the solar panel. We used a 20-volt solar panel and a forward-biased diode to stop the reverse charge flow to the solar panel, and the stored energy is used to run the machine [5]. The battery is connected to the motor driver's positive to positive and negative to negative terminals. In the motor driver, we can use two dc motors, so both dc motors are connected, and then a 5-volt supply for the Arduino Uno is connected by connecting Gnd to Gnd and +5 volts to Vin on the Arduino Uno board, and all components are connected using jumper wire [6]. After connecting the circuit and power supply, we need to connect the Bluetooth to the smartphone via mobile application. We used "RC CAR HP-05" to control the direction and speed of the machine. Fill the hopper with seeds, and then start the machine to run in the field to measure the seeds [4]. For turning right or left, we need to give a command from the smartphone, and controlling the servo motor speed can also be done from the smartphone.

Formula used for calculation of capacity and efficiency of the machine [7]

$$\text{Theoretical Field Capacity} = width\ (m) * \frac{speed\left(\frac{m}{hr}\right)}{10000}$$

Field Efficiency = Effective field capacity / Theoritical field capacity *100

Source code

The code used in the Arduino Uno to control the motors, servo motor, and Bluetooth module is here:

```
#include <SoftwareSerial.h>
#include <Servo.h>

// Define Bluetooth module pins
#define BT_RX 2
#define BT_TX 3

SoftwareSerial bluetooth(BT_RX, BT_TX);
Servo servoMotor; // Create a servo object to control a servo motor
// Motor A control pins
#define ENA 5
#define IN1 6
#define IN2 7

// Motor B control pins
#define ENB 9
#define IN3 10
#define IN4 11

void setup() {
// Set motor control pins as output
pinMode(ENA, OUTPUT);
pinMode(IN1, OUTPUT);
pinMode(IN2, OUTPUT);
pinMode(ENB, OUTPUT);
pinMode(IN3, OUTPUT);
pinMode(IN4, OUTPUT);
```

```
// Attach servo to pin 8
servoMotor.attach(8);

// Set the baud rate for Bluetooth communication
bluetooth.begin(9600);
}

void loop() {
if (bluetooth.available()) {
char command = bluetooth.read();
// Command 'F' to move both motors forward
if (command == 'F') {
digitalWrite(IN1, HIGH);
digitalWrite(IN2, LOW);
analogWrite(ENA, 255); // Full speed
digitalWrite(IN3, HIGH);
digitalWrite(IN4, LOW);
analogWrite(ENB, 255); // Full speed
}
// Command 'B' to move both motors backward
else if (command == 'B') {
digitalWrite(IN1, LOW);
digitalWrite(IN2, HIGH);
analogWrite(ENA, 255); // Full speed
digitalWrite(IN3, LOW);
digitalWrite(IN4, HIGH);
analogWrite(ENB, 255); // Full speed
}
// Command 'L' to turn left
else if (command == 'L') {
digitalWrite(IN1, LOW);
digitalWrite(IN2, HIGH);
analogWrite(ENA, 255); // Full speed
digitalWrite(IN3, HIGH);
digitalWrite(IN4, LOW);
analogWrite(ENB, 255); // Full speed
}
// Command 'R' to turn right
else if (command == 'R') {
digitalWrite(IN1, HIGH);
digitalWrite(IN2, LOW);
analogWrite(ENA, 255); // Full speed
digitalWrite(IN3, LOW);
digitalWrite(IN4, HIGH);
analogWrite(ENB, 255); // Full speed
}
// Command 'U' to move the servo continuously in one direction
else if (command == 'U') {
servoMotor.write(0); // Full speed in one direction
}
}
}
```

The setup links a Bluetooth device to the Arduino through pins 2 and 3. Pin 8 connects to a servo motor for precise movement, while pins 5, 6, 7 (Motor A) and 9, 10, and 11 (Motor B) control two DC motors for forward and backward motion. Commands sent via Bluetooth dictate motor actions and servo rotation, enabling bluetooth devices like smartphones to control the machine from far away.

Results and Discussion

The solar-powered seed metering mechanism, which is precisely constructed to be managed by bluetooth, has an amazing field efficiency of 82.55%. With a potential field capacity of 0.48 ha/hr and an actual field capacity of 0.40 ha/hr, it clearly outperforms typical fuel-powered implements in terms of operating efficiency and environmental stewardship. Furthermore, its energy consumption is painstakingly maintained, requiring only 59 watt-hours for two hours of daily operation and 413 watt-hours for a week, thanks to the flawlessly integrated solar panel and battery system. The seed drill mechanism exemplifies our ongoing commitment to sustainable farm machinery, ensuring that eco-conscious agriculture techniques are smoothly incorporated into the fabric of modern agricultural operations, all while maintaining uncompromising efficiency and productivity.

Summary and Conclusion

The introduction of the solar-powered, bluetooth-controlled seed drill mechanism represents a significant advancement in agricultural innovation and technological integration. In this machine which uses solar energy and bluetooth communication, goes beyond the usual reliance on fossil fuels, providing farmers with a sustainable, technologically advanced option. Its creation was a collective effort, combining interdisciplinary skills and incremental refinement to assure practicality and efficacy. The design and development of the solar-powered, bluetooth-controlled seed drill metering mechanism represent human inventiveness and a common commitment to crafting a greener, more efficient agricultural future, ready to tackle the challenges of a fast-changing landscape.

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