Design and Fabrication of Pesticide Spray Machine using blue tooth technology

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Abstract – Agriculture has a predominant role in our day to day life. Spraying of pesticides is an important task in agriculture for protecting the crops from pests. The conventional methods were person carrying a sprayer and manually actuating a lever to generate and pump the pesticide through a tube or a mobile vehicle carrying an inbuilt compressor and sprayer unit. Another major drawback in human operated systems is that the operator is exposed to the harmful chemicals while spraying which is extremely detrimental to operator's health. A battery powered semi automatic pesticide sprayer model consists of a re chargeable battery, two DC motors, pump, container, microcontroller and Bluetooth device which is operated by a wireless remote(range of 30 to 50meters) which runs on power source as a DC battery(12V, 9.5Ah). The capacity of the container in the sprayer was designed with 4 liters capacity for an uninterrupted operation of 10 minutes with the discharge rate of 0.556 lpm. Analysis of radiation data from Bangalore showed that the sprayer can be best operated during 9 AM to 5 PM. The vehicle is powered using an onboard battery powered which runs down the running cost. Besides reducing the cost of spraying, there is a saving on fuel as well. The farmers can do the spraying operation without human interference thus protecting them from noxious chemicals.

Index Terms- Dc battery, Dc motor, Dc pump, Wheels, Nozzle, Microcontroller, relay, Bluetooth.

1 INTRODUCTION

Agriculture has been the back bone of Indian and Nepalese economy and culture and it will be continued to remain as such for a long time in future. Spraying of pesticides is an important task in agriculture for protecting the crops from pests. In Nepal and India, near 70% peoples are dependent upon agriculture. Agriculture is a profession of many tedious processes and practices, one of which is spraying of pesticides in the crops. pesticide sprayer is a useful machine which is ergonomics, motion stable which is more efficient to workers, and the energy source used in non conventional. Hence it poses a great scope in future. Present scenario in agricultural field in Nepal and India related to sprayer is that farmers are using hand operated sprayer or motorized sprayer. Fuel operated spray pump exhaust carbon dioxide as pollutant which has a detrimental effect on our environment and human health. Hence, these conventional sprayers are not very efficient. This motivated us to design and fabricate a model that utilizes energy for spraying pesticides. Semi automatic pesticide sprayer which consists of a battery, motor, pump, container and microcontroller is a 3 wheeled vehicle which is operated by a wireless remote which runs on power source as a DC battery. So with this background, design and construction of powered sprayer system was made. The control of the vehicle is achieved using an inbuilt microcontroller unit which is programmed to respond to the Bluetooth wireless device.

2 LIERATURE SURVEY

F.Pezzi,V.Rondelli [1]

The performance of a sprayer fitted with two vertical adjustable air outlets has been studied in vineyards investigating the effects of changing speeds(1400 ,2000&2500 rpm) and the direction of the air- jet (90 &120 backward angle of the outlet side deflectors in relation to the treated row).

Isabelle Baldi, Pierre Lebailly [2]

Isabelle Baldi and Pierre Lebailly an epidemiologist, demonstrated in a study published in 2001 that exposure to a number of pesticides used on grapevines brought about a reduction in cognitive function (selective attention, memory, speech, ability to process abstract information) in winemakers in the Bardelais region.

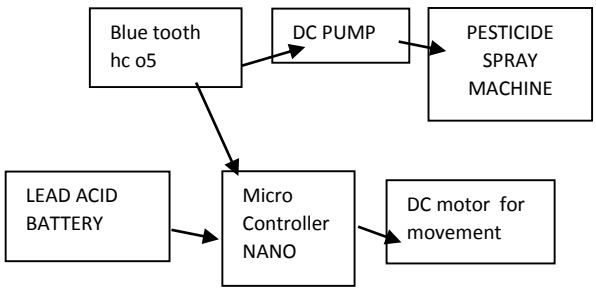
Burrell J, Brooke T and Beckwith.R [3]

Using ethnographic research methods, the authors studied the structure of the needs and priorities of people working in a vineyard to gain a better understanding of the potential for sensor networks in agriculture. The study's larger purpose is to find new directions and new topics that pervasive computing and sensor networks might address in designing technologies to support a broader range of users and activities.

Ruckelshausen and E. Wunder [4]

applications. The authors have developed a 3D simulation environment which allows the virtual test of the robot platform prior to its application.

3 METHODOLOGY



3.1 SELECTION OF COMPONENTS

The selection of component has been done according to the requirements. Following are the list of components with specification.

- panel
- DC battery
- DC motor
- DC pump
- Wheels
- Nozzle
- Microcontroller and relay
- Bluetooth

DC Battery –

- Weight of the battery: 2 kg
- Operating voltage: 12V
- Rated current: 7.5 Ah
- Type: lead acid battery

DC motor –

- Operating voltage: 12V
- Current: 2.1 amps
- Speed: 80 rpm
- Torque: 100 N- m

DC pump –

- Operating voltage: 12V
- Operating current: 0.5A
- Liquid discharge: 1 lpm
- Wheels – Material: nylon Dimension: 8cm diameter

Micro controller

Microcontroller	ATmega328P
Architecture	AVR
Operating Voltage	5 Volts
Flash Memory	32 KB of which 2 KB us
SRAM	2KB
Clock Speed	16 MHz
Analog I/O Pins	8
EEPROM	1 KB
DC Current per I/O Pins	40 milliAmps
Input Voltage	(7-12) Volt

What is Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike. Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs.

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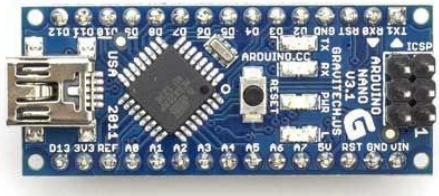
The software, too, is open-source, and it is growing through the contributions of users worldwide.

Why Arduino

Thanks to its simple and accessible user experience, Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to experiment with new musical instruments. Makers, of course, use it to build many of the projects exhibited at the Maker Faire, for example. Arduino is a key tool to learn new things. Anyone - children, hobbyists, artists, programmers - can start tinkering just following the step by step instructions of a kit, or sharing ideas online with other members of the Arduino community. There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard, and many others offer similar functionality. All of these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems:

- **Inexpensive** - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than $50
- **Cross-platform** - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.
- **Simple, clear programming environment** - The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works.
- **Open source and extensible software** - The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVR-C code directly into your Arduino programs
- **Open source and extensible hardware** - The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.



Relay

WORKING:

The bridge wave rectifier is used in power supply circuit. AC220V of input signal is given to the bridge wave rectifier circuit. During positive half cycle of the circuit diodes D1 and D3 will conduct, which produces the rectified output at the load. During the negative half cycle diodes D2 and D4 will conduct to produce the rectified output at the load. The load contains bypass capacitors, which bypasses the AC components and produces only DC components to the next circuit. Here we use IC7805, which acts as a voltage regulator to produce +5V of power supply required for LCD and the MICROCONTROLLER and IC7812 which produces +12V of power supply required for other devices.

Relay is an electromagnetically operated switch. It consists of a coil which is obtained by wounding the

wire and an electro-magnetic switch. Magnetic field is developed this acts as a temporary magnet. This phenomenon is used in working of relay.

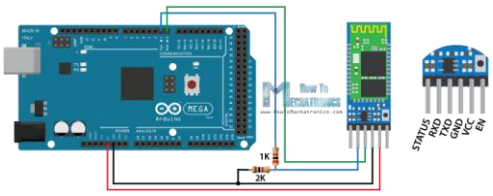
HC-05

For this tutorial I made two example, controlling the Arduino using a smartphone and controlling the Arduino using a laptop or a PC. In order not to overload this tutorial, in my next tutorial we will learn how we can configure the HC-05 Bluetooth module and make a Bluetooth communication between two separate Arduino Boards as master and slave devices.

Before we start with the first example, controlling an Arduino using a smartphone, let's take a closer look at the HC-05 Bluetooth module. Comparing it to the HC-06 module, which can only be set as a Slave, the HC-05 can be set as Master as well which enables making a communication between two separate Arduino Boards. There are several different versions of this this module but I recommend the one that comes on a breakout board because in that way it's much easier to be connected. The HC-05 module is a Bluetooth SPP (Serial Port Protocol) module, which means it communicates with the Arduino via the Serial Communication.

Circuit Schematics

Here's how we need to connect the module to the Arduino Board.



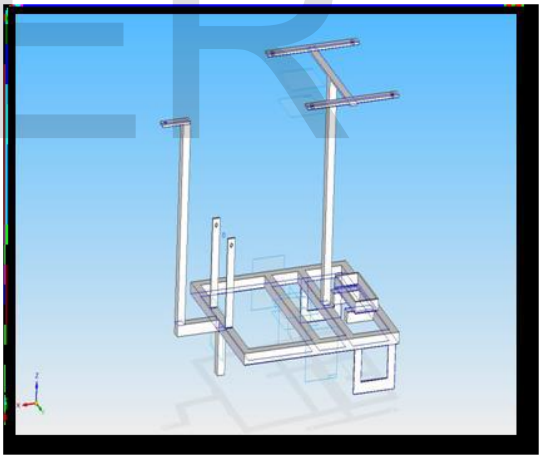
The particular module that I have can be powered from 3.6 to 6 volts, because it comes on breakout board which contains a voltage regulator. However, the logic voltage level of the data pins is 3.3V. So, the line between the Arduino TX (Transmit Pin, which has 5V output) and the Bluetooth module RX (Receive Pin, which supports only 3.3V) needs to be connected through a voltage divider in order not to burn the module. On the other hand, the line between the Bluetooth module TX pin and the Arduino RX pin can be connected directly because the 3.3V signal from the Bluetooth module is enough to be accepted as a high logic at the Arduino Board.

PROPERTIES

- Low wear and extremely abrasion resistance
- Low roll resistance.
- Possible to carry heavy loads

3.2 FINITE ELEMENT ANALYSIS

- Chassis frame is analyzed for the displacement for the hydrostatic load acting on it. Initially in the ANSYS workbench the static structural analysis module is selected for the analysis. For the different load conditions analysis has been carried out.



3.3 LEAD ACID BATTERY

The answer is YES. Lead-acid is the oldest rechargeable battery in existence. Invented by the French physician Gaston Planté in 1859, lead-acid was the first rechargeable battery for commercial use. 150 years later, we still have no cost-effective alternatives for cars, wheelchairs, scooters, golf carts and UPS systems. The lead-acid battery has retained a market share in applications where newer battery chemistries would either be too expensive. Lead-acid does not lend itself to fast charging. Typical charge time is 8 to 16 hours. A periodic fully saturated charge is essential to prevent sulfation and the battery must always be stored in a charged state.

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Leaving the battery in a discharged condition causes sulfation and a recharge may not be possible.

Finding the ideal charge voltage limit is critical. A high voltage (above 2.40V/cell) produces good battery performance but shortens the service life due to grid corrosion on the positive plate. A low voltage limit is subject to sulfation on the negative plate. Leaving the battery on float charge for a prolonged time does not cause damage.
Lead-acid does not like deep cycling. A full discharge causes extra strain and each cycle robs the battery of some service life. This wear-down characteristic also applies to other battery chemistries in varying degrees. To prevent the battery from being stressed through repetitive deep discharge, a larger battery is recommended. Lead-acid is inexpensive but the operational costs can be higher than a nickel-based system if repetitive full cycles are required.Depending on the depth of discharge and operating temperature, the sealed lead-acid provides 200 to 300 discharge/charge cycles. The primary reason for its relatively short cycle life is grid corrosion of the positive electrode, depletion of the active material and expansion of the positive plates. These changes are most prevalent at higher operating temperatures. Cycling does not prevent or reverse the trend.
The lead-acid battery has one of the lowest energy densities, making it unsuitable for portable devices. In addition, the performance at low temperatures is marginal. The self-discharge is about 40% per year, one of the best on rechargeable batteries. In comparison, nickel-cadmium self-discharges this amount in three months. The high lead content makes the lead-acid environmentally unfriendly.

4 ASSEMBLY

First of all pneumatic pump is fitted to the base with the help of nuts and bolt, visor are used over here for the rigid fitting and to avoid vibration and miss alignment. Then after one end of the connecting rod is attached to the disk with help of the bearing nut for the smooth rotational motion of the disk and the rod Other end of the connecting rod is fitted to the piston rod of the pump by bringing the disk at TDC position and the piston rod completely inside the cylinder. A branch tee is connected to the pump from which the suction and delivery pipe are provided along with the nerves at both end. The delivery and suction pipe are adjusted in the sump and the overhead tank. Then after the motor is connected to the 12vol battery connected in series and the battery is simultaneously charged with the help of the 20watt panel.

5 DESCRIPTION

First we need to define the pin to which our LED will be connected and a variable in which we will store the data coming from the smartphone. In the setup section we need to define the LED pin as output and set it low right away. As mention previously, we will use the serial communication so we need to begin the serial communication at 38400 baud rate, which is the default baud rate of the Bluetooth module. In the loop section with the Serial.available() function we will check whether there is available data in the serial port to be read. This means that when we will send data to the Bluetooth module this statement will be true so then using the Serial.read() function we will read that data and put it into the “state” variable. So if the Arduino receive the character ‘0’ it will turn the LED off and using the Serial.println() function it will send back to the smartphone, via the serial port, the String “LED: OFF”. Additionally we will reset the “state” variable to 0 so that the two above lines will be executed only once. Note here that the “state” variable is integer, so when we receive the character ‘0’ that comes from smartphone, the actual value of the integer “state” variable is 48, which corresponds to character ‘0’, according to the ASCII table.. That’s why in the “if” statement we are comparing the “state” variable to a character ‘0’. On the other hand, if the received character is ‘1’, the LED will light up and the String “LED: ON” will be sent back. Now the code is ready to be uploaded but in order to do that we need to unplug the TX and RX lines because when uploading the Arduino uses the serial communication so the pins RX (digital pin 0) and TX (digital pin1) are busy. We can avoid this step if we use the other TX and RX pins of the Arduino Board, but in that case we will have to use the SoftwareSerial.h library for the serial communication.

Nozzle

The multi nozzle sprayer is illustrated here fitted with a four nozzle boom giving a spray width of up to 1500mm (60") achieved by positioning the boom at the top of the bracket. **The nozzles are fitted to a turn-over turrent holder giving a choice of three types of nozzles.**

Theis mounted on a robust tray three wheel chassis. The pump is a 12 volt diaphragm pump powered from its own integral battery, which a charger supplied. The pump is run on a pressure system which means that when the spray is shut off the pump shuts down, similarly open and the pump restarts.

Typically the average spray time per battery charge is around five hours normal spray use (3.5 hours intermittent), for continuous spraying so on/off time, refill and movement actions will enhance the overall spray time.

The low to ground four nozzle boom minimises drift and therefore close-to-edge work can be carried out. A brass trigger lance is supplied for spot spraying. A pressure gauge and a by-pass regulator are fitted for the hand lance.

The handles on the sprayer are adjustable to suit the operator. A tow bar is also supplied with each machine.

Dc pump

- Size: 36x85mm Material: plastic Rated voltage: DC12V
- Service voltage: DC6V-14V Rated current: 0.75A Pressure: 2.7kg ±10%
- Life span: 30000 hrs Suction head: 1.0m Noise: max 50dB
- Package Included: 1 x 12V Water Pump

6 RESULT ANALYSIS

Theoretical Calculations

Losses Ignored
Bore Diameter= 5mm
Length of stroke= 150mm
Head or height h=36”
Speed of rotation N=15rpm
Pipe Dia= 6mm
Pipe Length=36”
Suction lift= 0.5m
$Q = \pi \times d2 \times L \times N = \pi \times (0.05)2 \times 0.15 \times 15 = 7.35 \times 10\text{-}5$ m3/s
4×60 4×60
$P = \rho \times g \times h = 1000 \times 9.81 \times 3.5 = 2.5$Watt
Max speed (piston) $= \omega \times r = 2 \times \pi \times N \times r = 0.07$m/s
60
Max velocity of water in delivery pipe = 0.07×0.052
0.0092

= 2.16m/s
Head loss friction = 2×ρ×L×V2
g×D
Supply Inertia head = L×dp2×ω2×r
g×dd2
= 3.5×.052×1.42×.05
9.8×0.009
= 1.05m
Suction Inertia head = -0.26m

Selection of electric motor

A) DC motor SPEED (N) = 100 RPM

B) VOLTAGE (V) = 12 VOLT

C) WATTS = 18 WATT

Torque of the motor

A) Torque (T) = (P X 60) / (2 X 3.14 X N)

= (18X 60) / (2 X 3.14 X 100)

= 1.73Nm

i.e. Torque =1.73 N-mm

B) The shaft is made of MS and its allowable shear stress = 42 MPa

Electrical (electric) power equation

A) Power (P) = I × V Where,

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V = 12 V

P = 18 W Then,

I=18/12 =1.5

A B) In hp = 0.02414hp

FRAME

Loading:-
Load Calculations-
The frame will support the shaft assembly with includes a tank, DC pump ,battery and a spray gun .
Weight of a tank - 5 kgs.
Weight of a DC pump -2 kg
Battery 12 volt 7 ahc -3kg
spray gun – 1 kg
Thus weight of a total assembly
=5+.2+3+1 =11 kg
Thus for safer size we will consider weight = 11 kgs

Wheel

Material: plastic

Dimension: 6" x 2" diameter

Properties: Low wear and extremely abrasion

resistance Low roll resistance.

Possible to carry heavy loads

Liquid Storage

Tank Tank capacity =10 ltrs.

Material = PVC

Nozzle

discharge rate is .5 lit/min.

Selection of Spray Pump

DESIGN CALCULATIONS.

According to Spraying Capacity & Discharge Capacity Of

Spray pump Is Selected

Type : Centrifugal Pump.

Liquid Discharge : 0.5lit/min to 1lit/min.

Speed : 1500 rpm.

Suction Head (hs) = 0.5m.

Discharge Head (hd)= 3m.

Suction pipe Diameter : 12mm =12*10^-3m.

Discharge pipe Diameter : 8mm =8*10^-3m

Overall Efficiency Of The Pump

η= $W*Hm$ /1000 xS.P.

Where, S.P = Power Required To Drive The Pump.

Hm = Monometric Head (in m)

η= Overall Efficiency Of The Pump (Assume it is 60%)

η= $\rho*g*Q*Hm$ /1000 xS.P

η= $\rho*g*Q*Hm$ /1000 $*S.P$

η= 1000 $*9.81*8.33*10-6$ $*Hm\ S.P$

, Q= 1lit/min= 1.66*10^-5 m^3/sec.

Assume Overall Efficiency of Pump η=60%

Hm= Manometric Head

Hm=($Po\ \rho*g$ + Vo^2 $2*g$ +Zo) –($Pi\ \rho*g$ + Vi^2 $2*g$ +Zi)

Where , $Po/\ \rho*g$ = Pressure head at outlet of pump (hd) = 3m.

Vo^2 /$2*g$ = Velocity head at outlet of pump = Vd^2 /$2*g$

$Pi/\ \rho*g$ = Pressure head at inlet of pump (hs) = 0.5m.

Vi^2/ $2*g$ = Velocity head at inlet of pump = Vs^2/ $2*g$

Hm =(Vd^2 /$2*g$ + 3)- (0.5+Vs^2/ $2*g$)

Vd(Velocity at Discharge)= $Disc\square arge\ /Area\ of\ Delivery\ pipe$ = 1.66∗10^−5 /π /4 ∗8∗10^−3

= 2.16*10^-3 m/sec.

Vs(Velocity at Suction) = $Disc\square arge/\ Area\ of\ suction\ pipe$ = 1.66∗10^−5 /π/ 4 ∗12∗10^−3 =1.76*10^-3 m/sec.

Hm = 3+ ((2.16∗10^−3)^2 /2∗9.81) - 0.5 +($1.76*10-3^{\ 2}$ /2∗9.81)

Hm = 14.71-2.45

Hm = 12.26 meter.

Now, We know that , Overall Efficiency of the pum

η= $W*Hm$ /1000 /S.P

putting the above value in the equation, we get the power of pump.

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Rearrangement of Above equation

S.P = $\rho * g * Q * Hm$/ 1000∗n

= 1000∗9.81∗1.66∗10−5 ∗12.26 /1000∗0.60

= 3.327*10^-3

= 0.00327*10^3

= 3.27 Watte ~ 3.50 Watte .

Power required to the pump is 3.50 Watte.

Base

Length of the base = 18”

With of the base = 12”

Height of the base = 80mm

Material = M.S

7 CONCLUSION

This project demonstrates the implementation of robotics and mechatronics in the field of agriculture. This being a test model the robustness of the vehicle is not very high. The performance is satisfactory under laboratory condition. The model gave a fairly good rate of area coverage and the cost of operation as calculated was also reasonably low.
In addition the safety and long term health of the farmers is ensured by eliminating human labor completely from this process. It does not compromise the performance of a petrol based pesticide sprayer.

8 AKNOWLEDGMENT

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