Design & Development of a Prototype of an Agri-bot for Multiple Farming Applications & n,p, k Sensing (Nitrate, Phosphorus, Potassium)

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Abstract- *The purpose of the project is to execute the design of a multi purpose agricultural robot that will be utilized for assessing and smartly monitoring soil nutrient quality. Same should be capable of traversing on un even , irregular terrains, of lightweight , but powerful design.The vehicle so designed can also be adapted in future to perform weeding , fertilizer spraying, seeding operations .*

Since it is an autonomous vehicle, a GPS mechanism can be augmented to monitor its movement and tracking of various field and site conditions, as a futuristic development.

Keywords: Autonomous, GPS

I INTRODUCTION

An increase in the application of the automation and informatics in the agricultural area can be observed in recent times. New agricultural practices, related to the Precision Agriculture, have enhanced the importance in the research of embedded sensors and communication networks for the study of spatial variability and remote sensing applications. A certain degree of automation is necessary for the use of these new practices that depends on some recent technologies only adapted
for the agricultural area such as the case of the global positioning systems, geographic information systems and the interconnection of devices and controllers used in the agricultural machinery A strong tendency is development of mobile robots and autonomous vehicles for application in specific tasks, improving the efficiency and giving better results (soil compaction reduction and machine operator absence) when compared with the use of traditional large tractors.

II OBJECTIVES

1. Arriving at an optimal design of an agricultural robot with multiple functions.
2. Establishment of testing & accurate sensing systems for nitrogen, Phosphorus and Potassium contents in soil.
3. These vehicles should be capable of working 24 hours a day all year round, in most weather conditions and have the intelligence embedded within them to behave sensibly in a semi-natural environment over long periods of time, unattended, while carrying out a useful task.
4. Subject robot can be adapted to perform weeding or seeding operations as well.
5. Collect sand/soil samples for testing analysis.

Fig 1 Mobile Robot

Mobile robots are increasingly being used in high-risk, rough terrain situations, such as planetary exploration1. Future missions will require mobile robots to perform difficult mobility tasks in rough terrain. Such tasks can result in loss of vehicle stability, leading to tipover, and loss of wheel traction, leading to entrapment. Clearly, tip over instability can result in rover damage and total mission failure.

III DESIGN SELECTION

This is a special design which allows the rover to traverse many different terrains while keeping the body of the rover stable. Since the wheels are not connected to each other, it also allows the two sides of the rover to go on different slopes simultaneously.
This design allows to tilt 45 degrees in any direction without flipping over (though automatic sensors prevent it from going over 30 deg.).

IV PROBLEM STATEMENT

There are other designs which differ from Rocker-Bogie suspension, but most of these also use six wheels. Having more wheels increases traction and stability, resulting in a safer rover overall. You could make a design with four wheels, but this would be less stable.
Alternatively, you could put 8 or 10 wheels on,. but this would drastically increase the cost and weight of the rover. Therefore, 6 wheels is a good middle ground that provides lots of traction and stability without being too heavy

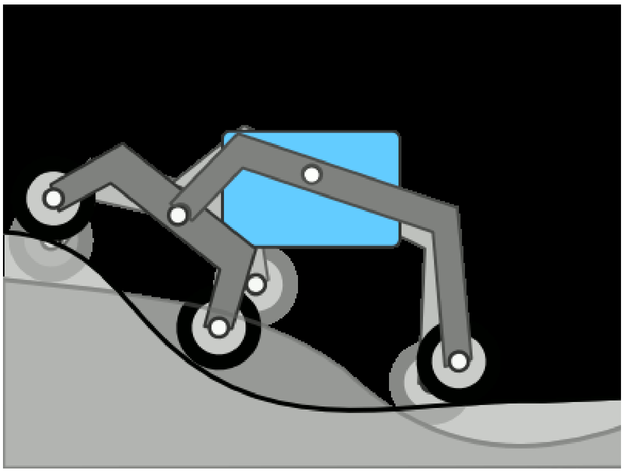

Fig 3 Six wheeled Rocker Bogie Suspension

The fundamental building blocks of this proposed system are Microcontroller, Sensors ,Bluetooth module, Proposed system shown in figure

Fig 2.: Proposed System

VI KINEMATIC STRUCTURE

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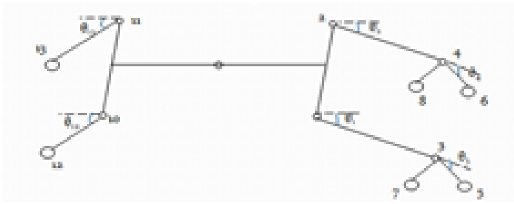

Fig.4 Kinematic structure

VII DENAVIT HARTENBURG TABLE

V DESIGN CONCEPT

.

Frame	θ	D	a	α
Right front leg	θ_1	a_1	L_1	0
Left Front leg	θ_2	$-a_2$	L_2	0
Right rear leg	$180-\theta_2$	0	$(a_3^2+p_2^2)^{0.5}$	-90
Left rear leg	$180-\theta_1$	0	$(a_4^2+p_2^2)^{0.5}$	-90

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$$ {}^{i-1}T_i = \begin{bmatrix} c\theta_i & -s\theta_i & 0 & \alpha_{i-1} \\ s\,\theta_i c\,\alpha_{i-1} & c\,\theta_i\, c\alpha_{i-1} & -s\,\alpha_{i-1} & -d_i\, s\,\alpha_{i-1} \\ s\theta_i\, s\,\alpha_{i-1} & c\,\theta_i\, s\alpha_{i-1} & c\,\alpha_{i-1} & d_i\, c\,\alpha_{i-1} \\ 0 & 0 & 0 & 1 \end{bmatrix} $$

$$ T_i = \begin{bmatrix} c\theta_i & -s\theta_i c\alpha_i & s\theta_i s\alpha_{i-1} & \alpha_i c\theta_i \\ s\,\theta_i & c\,\theta_i\, c\alpha_i & -c\,\theta_i\, s\alpha_i & a_i\, s\,\theta_i \\ 0 & s\alpha_i & c\,\alpha_i & d_i \\ 0 & 0 & 0 & 1 \end{bmatrix} $$

VIII MOTOR SELECTION

Fig 5 DC motor

Detailed description of some of the components Side shaft DC motors

Six side shaft motors (30 rpm) are used for driving six wheels in order to move the Agri-bot in different directions. The shaft motors with four wheels which is used in Agribot is shown in Figure above.

Gear motor is an assembly composed of an electric motor and a reduction gear in a single unit. The most common types have planetary, planetary-lantern and wave transmissions. For greater compactness, the driving gear of the reduction gear is mounted directly on the motor shaft. Gear motors are used in universal drives for general use; they are manufactured serially by specialized enterprises. They can operate in a horizontal, vertical, or tilted position.

Fig 6 Gear motor

IX L298N MOTOR CONTROLLER

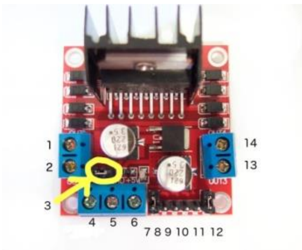

Fig 7 L298N

. DC motor 1 "-" or stepper motor A-

3. 12V jumper - remove this if using a supply voltage greater than 12V DC. This enables power to the on board 5V regulator

4. Connect motor supply voltage here, maximum of 35V DC. Remove 12V jumper if >12V DC

5. GND

6. 5V output if 12V jumper in place, ideal for powering your Arduino (etc)

7. DC motor 1 enable jumper. Leave this in place when using a stepper motor. Connect to PWM output for DC motor speed control.

8. IN1

9. IN2

10. IN3

11. IN4

12. DC motor 2 enable jumper. Leave this in place when using a stepper motor. Connect to PWM output for DC motor speed control.

13. DC motor 2 "+" or stepper motor B+

14. DC motor 2 "-" or stepper motor B-

X POWER MODULE

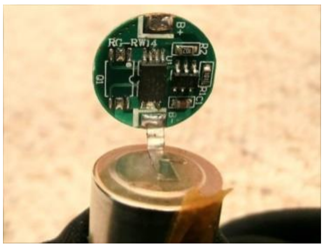

Fig 8 Li-Ion battery

The three primary functional components of a lithium-ion battery are the positive and negative electrodes and electrolyte. Generally, the negative electrode of a conventional lithium-ion cell is made from carbon. The positive electrode is a metal oxide, and the electrolyte is a lithium salt in an organic solvent. The electrochemical roles of the electrodes reverse between anode and cathode, depending on the direction of current flow through the cell.

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The most commercially popular negative electrode is graphite. The positive electrode is generally one of three materials: a layered oxide(such as lithium cobalt oxide), a poly anion (such as lithium iron phosphate) or a spinel(such as lithium manganese oxide). Recently, graphene based electrodes (based on 2D and 3D structures of graphene) have also been used as electrodes for lithium batteries.

The electrolyte is typically a mixture of organic carbonates such as ethylene carbonate or diethyl carbonate containing complexes of lithium ions. These non-aqueous electrolytes generally use non-coordinating anion salts such as lithium hexafluorophosphate ($LiPF_6$ Lithium hexa fluoro arsenate ($LiAsF_6$) Lithiumperchlorate($LiClO_4$)

Fig 9 _Trials of Robot operation in farm

XI EMBEDDED C PROGRAM (Extract)

```
define light_FR  14    //LED Front Right   pin A0 for Arduino Uno

#define light_FL  15    //LED Front Left    pin A1 for Arduino Uno

#define light_BR  16    //LED Back Right    pin A2 for Arduino Uno

#define light_BL  17    //LED Back Left     pin A3 for Arduino Uno

#define horn_Buzz 18    //Horn Buzzer       pin A4 for Arduino Uno

#define ENA_m1 5        // Enable/speed motor Front Right

#define ENB_m1 6        // Enable/speed motor Back Right

#define ENA_m2 10       // Enable/speed motor Front Left
```

XII ELECTRICAL CKT

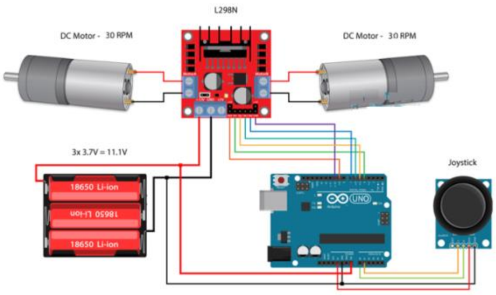
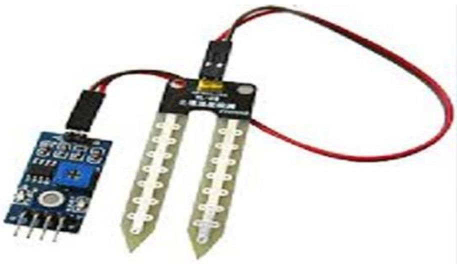


Fig 10 Motor connections-Arduino

ELECTRICAL CKT



connections-Arduino

Fig 11 Soil sensor

XIII ION SENSITIVE FIELD EFFECTIVE TRANSISTOR

The electrochemical sensor consists of two electrodes which responds to targeted ion and transforms the reactions to detectable electrical signals. Ion Selective Electrode (ISE) and Ion Selective Field Effect Transistor (ISFET) are the two types of commonly used potentiometric electrochemical sensor for soil nutrient detection. Here ISE is not suitable for real-time sensing applications because of time delay (several minutes). An electrochemical sensor consists of a diffusion barrier, a sensing electrode and a counter electrode. In an environment free of chemically reactive gases, oxygen diffuses into the cell and adsorbs on both electrode. The result is a stable potential between the two in which the little current flows. The cell chemical process at this point,

O2 + 2H2O +4e- ---à 4OH-

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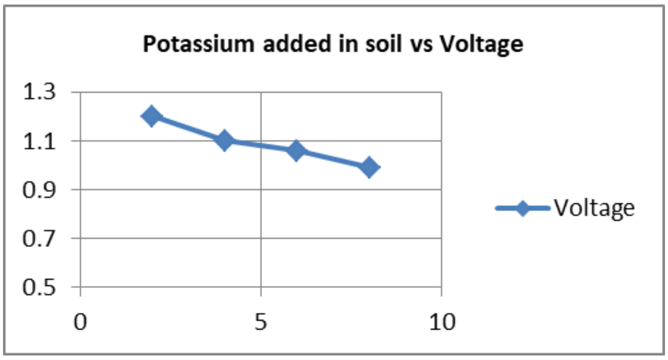
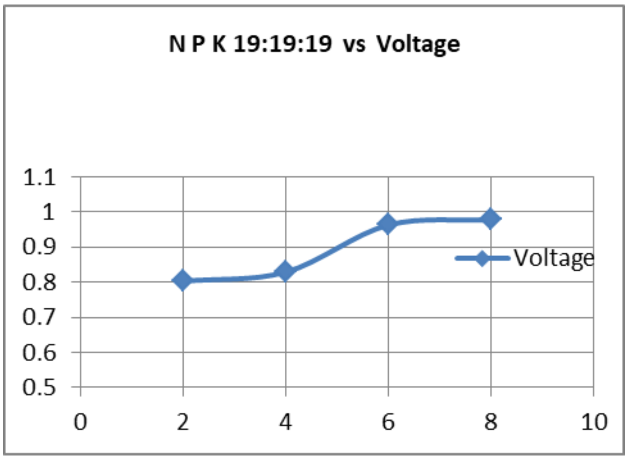
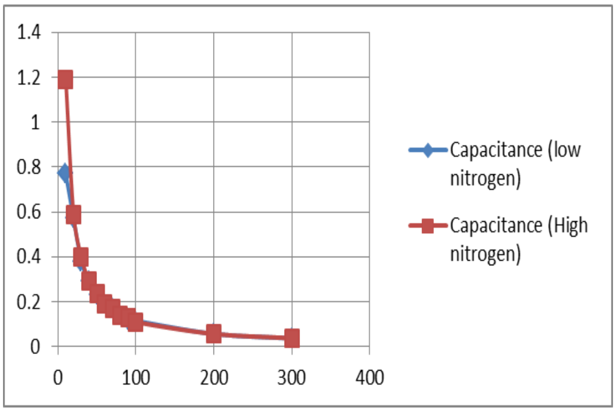
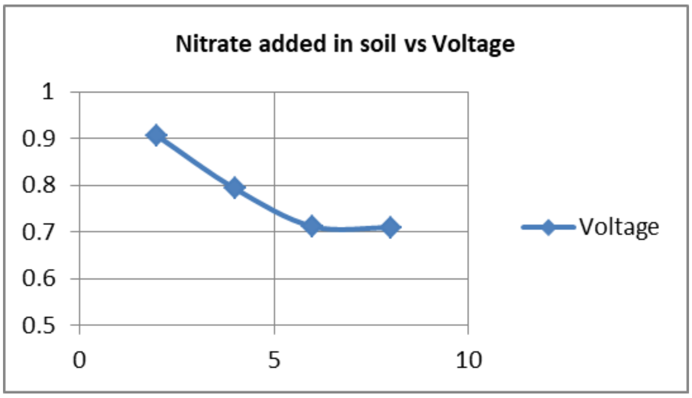
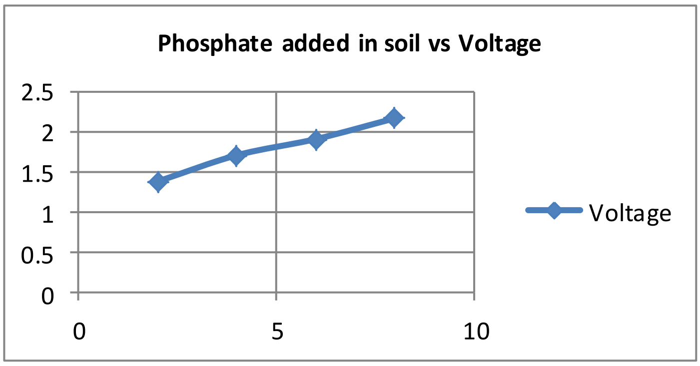
XIV N P K TESTS & TEST RESULTS











suggests soil is rich in Potassium.

2. If voltage is below 1 V, soil is nitrate rich.

3. If voltage is > 2 V, it is phosphate oriented.

Nitrate added gms/100 ml of water

Phosphate added gms/100 ml of water

Freq.(Hz)⟶

Graph- Soil capacitance(μF) vs Signal freq.(Hz)
High Nitrate vs Low nitrate soil

XV PRESENT STATUS

Fig 12 Agri-bot

Fig 13 Design of-fluted drill

XVI FURTHER SCOPE OF PROJECT

1. It can be incorporated with GPS for convenience of tracking automatically
2. Thereby it can be utilized to collect and analyse soil samples from different locations.
3. A smart system of soil nutrient assessment and optimal re-nourishing can be facilitated in the deficient areas.
4. It can be used to carry out weeding.
5. Can be transformed to perform seeding operation.
6. Similarly designed drones can be engineered for other applications, viz. defense, etc

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[5] Analysis of a Kinematic Model for a Forestry Six-Wheeled Luffing Articulated Vehicle Chassis
Han Dongtao1,2, Liu Jinhao*,1, Kan Jiangming1 and Tang Weiguo1
The chassis is a key component of forestry vehicular equipment that directly determines its ability to drive and climb in rough mountainous or forested terrain. A six-wheeled luffing articulated chassis was designed to scale obstacles on forested land. This paper discusses the use of the Denavit-Hartenberg method to establish a kinematic model for this vehicle chassis; positive solutions of the kinematic model were then applied to an analysis of the luffing capabilities of the six-wheeled luffing articulated chassis.