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Rocker Bogie Mechanism

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***Abstract*: The proposed system has been utilized with a rocker bogie mechanism to overcome the rough terrains while maintaining the stability in the fields. This portable system uses the wireless mode of communication to communicate between system and the sensing module. This system has been assembled to optimize the usage of water, furthermore reduce wastage of manpower in the agricultural fields. The system is imparted with an Arduino, a soil moisture sensor hence competent to sense the moisture content of the soil directed by an electric powered forklift to be raised wherever necessary and to notify the user accordingly. This system can be operated using wireless communication which moves the robot manually without physical human interference. The system is made up of (name of material) and is provided with motors with rough terrain wheels capable of taking effective rotation when moved back and forth.**

***Keywords*: Agriculture, DC motor, rocker bogie mechanism, soil moisture sensor, rover.**

1. Introduction

Today agriculture is a leading occupation in many countries and a significant occupation (for around 60% population). It is one of the most contributing sectors in India with a GDP of 20.2% in the year 2022 [7]. Although being a leading occupation as well as largest practicing occupation, only few developments are available to help the farmers. Involving many stages like soil preparation, sowing, weeding, crop protection and the most important comes the irrigation system. These irrigation systems like drip and sprinkler systems are used on a large scale as these could boost the water productivity. Despite these advantages the irrigation systems could not meet the needs of watering the crops. While watering the crops it is necessary to understand the need of water for each crop. Unfortunately, many crops die every year due to improper and insufficient watering through irrigation. The irrigation techniques till date are stagnant and are neither portable nor cost effective. In this case the proposed system has been developed to perform the precise operations in irrigation of farms, which implements the use of a soil moisture sensor which will further sense the moisture and will notify the user accordingly, based on the moisture level sensed the farmers will be able to know the right time to water the crops through irrigating systems, also it implements an idea of bogie mechanism, a very known rover mechanism developed by NASA for the operations on mars. This system has been assembled to optimize the usage of water as well as efficiently water the crops as per their needs furthermore reduce wastage of manpower in the agricultural fields.

2. Literature Review

S. Gokul., et al., [1] (2020) has reported the "Plant Irrigation water Sprinkler robot" which uses a robot with single sprinkler and equipped with geo fencing sensors to cover complete fields without manual intervention.

Hema N., et al., [2] has reported the "Plant watering autonomous Mobile robot" which implements the mobile robot and temperature-humidity sensing modules and uses wireless communication equipped with radio frequency identification module furthermore locating plants and autonomously watering them.

Devdutt., et al.,[3] has reported Plant Watering Robot "Plant Bot". this robot checks the soil moisture and waters the plant by identifying the soil moisture content in the soil. This robot is provided with solar panel for charging, and a 5 L of water storage tank. The android application has been developed to manually operate the robot.

3. Objectives

- Carefully Controlling the irrigation process and watering the crops.
- Reducing wastage of crops due to improper amount of watering.
- Achieving high quality and efficient watering of plants.
- To make a system having lower costs and high efficiency.

4. Methodology/Experimental

A. Materials/Components

Microcontroller: The Arduino Microcontroller has been used and will act as the brain of our system. It will transmit the data received from the soil moisture sensor.

DC Motors: 6 DC motors of rpm (30) and 12V each drawing a current 400 mA up to max are used to drive the wheels respectively.

Wheels: Diameter = 7cm (all wheels)

Battery: Two 9 volt non rechargeable batteries

Bluetooth module: HC-05

Four pins are used in this namely VCC, ground, TXD and RXD Ground is connected to ground of Arduino and power is connected to 5V of Arduino through breadboard.

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Soil Moisture sensor: Three pins are used in this namely power, ground and analog input. Analog pin is connected to A0 of Arduino and remaining to ground and power to Arduino.

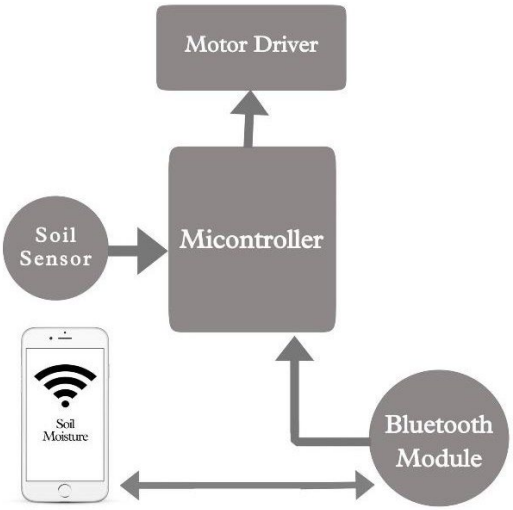

Fig. 1. Block diagram of the system

B. Design

The proposed system is a rover like robot consisting of four wheels and a robotic chassis. The wheels and the structure of the system allows it to overcome the rough terrains and to maintain its stability during the operation. Each of the wheels are attached to the motors each having equal rpm (30) to avoid the unnecessary path deflections during the operations. The processor controls the motors and hence the rover also. It has a soil moisture sensor set up to sense the soil moisture content and send it to the processor and further to the user through Bluetooth module.

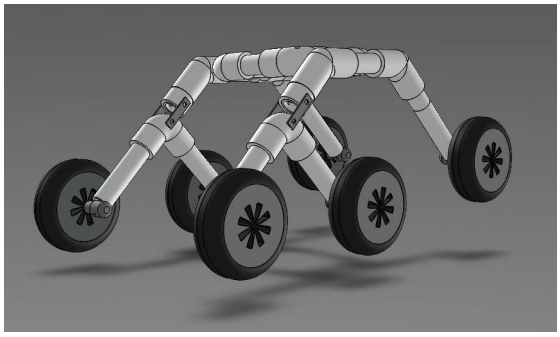

Fig. 2. Design

The CAD model for the assembly of the rocker bogie mechanism is shown in Fig.1. The rods are made up of PVC but the material can be changed according to the need but generally, PVC would work perfectly fine as the material of the chassis. Rubber tires have been used in order to increase friction between the ground and the rover.

When it comes to designing of this rover, we need to set some kinematic constraints in order to get the desired springless suspension system.

Assuming the length of the obstacle which we need to be overcome is 200x240mm, we need to decide the wheel radius.

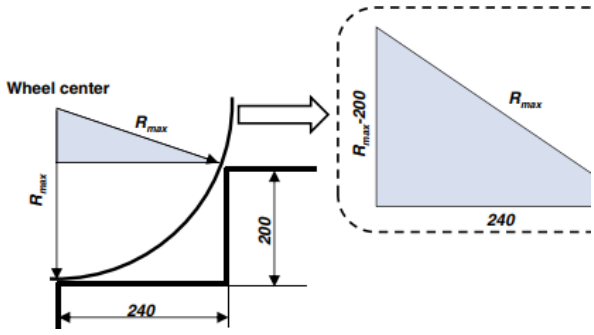

Fig. 2.

The kinematic constraint on the maximum wheel radius is described through Fig. 2 where before climbing the upper step of stair, a wheel center can stay on the tread of stair in order to steadily maintain its posture. Therefore, these constraints on the wheel radius R_i, i= 1, 2, 3 can be expressed by 25 mm ≤ R_i ≤ 244 mm:

Next, each link length li should be greater than the wheel radius R_i, i= 1, 2, 3 because undesired interferences between the wheels themselves may occur if not so. Assuming that the overall size of the rocker-bogie mechanism in this study is smaller than 1 m3, the maximum link length is bounded by 1 m, which is simply given by $R_i < l_i \leq 1000$ mm.

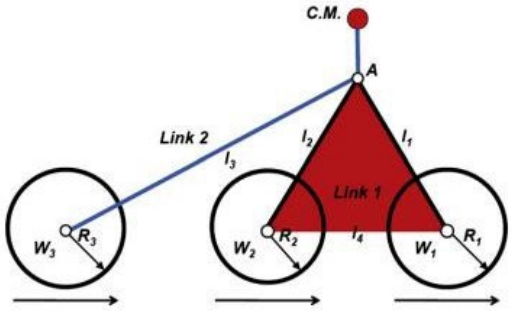

Fig. 3.

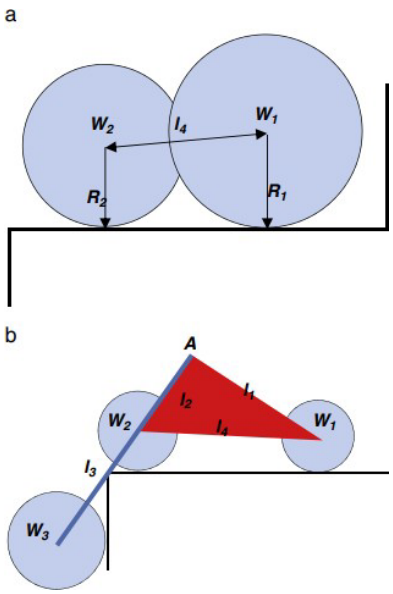

Fig. 4.

In addition, since two wheels W_1 and W_2 of the bogie mechanism are connected through the Link 1, the link length l_4 should be greater than R_1+R_2 to avoid the interference between those wheels as described in Fig. 4(a). Similarly, another condition may be derived in order to avoid the interference between two wheels W_2 and W_3 as shown in Fig. 4(b). Combined with a geometric condition that the Link 1 is in the shape of a triangle, the above constraints are summarized by,

$$l4 > R1 + R2$$
$$l3 - R3 > l2 + R2$$
$$l1 + l2 \geq l4;\ l2 + l4 \geq l1;\ l4 + l1 \geq l2$$

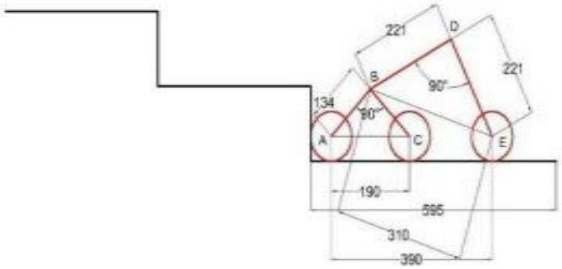

Fig. 5.

Assuming the staircase to be an obstacle, the stair height and length 150 mm and 370 mm respectively. Now, need to obtain the distance between first and second wheel through CAD software (190 mm). Considering the right-angled triangle ABC,

Using Pythagoras in ΔABC(Fig. 5) assume lengths AB and BC is x.

$AC^2 = AB^2 + BC^2$

$190^2 = x^2 + x^2$

$190^2 = 2x^2$ x = 134 mm

Hence, AB = BC =134 mm

Similarly, to find dimensions for rocker linkages first two wheel pairs should be placed at horizontal position. Third wheel pair should nearly complete its rising before starting of rising of first pair of wheel. By placing wheel in such manner we obtained dimension of link BC

Now consider ΔBDE (Fig. 5), $BE^2 = BD^2 + DE^2$

$311^2 = 2y^2$ y = 221 mm

Hence, BD = DE = 221 mm (Fig. 5)

C. Material Selection

Since the rover is not subjected to any sudden unforeseen forces and does not have a very mechanically exhaustive work to do, we plan on using Aluminum 6061 or recycled Aluminum as it is quite easily accessible and is cheap. Aluminum 6061(any grade) costs only Rs. 500/-per kg Which makes it the least expensive ye the most performing aluminum alloy. Properties of which are given in Fig. 6.

5. Future Scope

With increasing scope and development in agriculture sector, this system in future can be modified and provided with the solar panels with the rechargeable batteries instead of a traditional battery to make the system more efficient. The sprinklers can be attached along with an overhead tank to spray the pesticides remotely. The cheap cost of this system is additional advantage and could reduce the investment costs of the farmers. This system can further be developed with advanced technology which can alert the farmers in case of emergencies through messages on their mobile phones this system promises a future with a new hope with great potential in agriculture sector. According to the literature survey we found that the battery consumption of rover is more and also charging of those batteries is a limitation. To avoid this problem solar panel can be induced on the project. The speed of rovers is comparatively slow which can be increased by implementing the idea of separate motor for each wheel The rovers are only capable to move on terrain surface or avoid obstacles, but it can be enhanced for stair climbing. By considering all these points we have an idea of making a Solar based Rocker-Bogie Mechanism which can overcome all points considered in problem statements and can also be used for stair climbing purpose.

Chemical Composition

Element	Content(%)
Aluminium	97.9
Magnesium	1
Silicon	0.6
Copper	0.28
Chromium	0.2

Physical Properties

Properties	Metric
Density	2.7g/cc
Melting point	588°C

Mechanical Properties

Properties	Metric Values
Tensile Strength	310MPa
Yield Strength	276MPa
Shear Strength	207MPa
Fatigue Strength	96.5MPa
Elastic Modulus	68.9GPa
Poission's Ratio	0.33
Elongation	12 - 17 %
Brinell Hardness	95

Fig. 6.

6. Conclusion

It can be concluded that we have made and, we have come up with a low-cost Rocker bogie mechanism with soil moisture sensor. The project carried out by will make an impressing task in the field of Agriculture. It is very useful for detecting the moisture levels to know the right time to water the crops. This project has also reduced the cost involved in the concern. Project has been designed to perform the entire requirement task accurately, which will be provided.

Acknowledgment

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