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Wireless Control of Rockerbogie Mechanism Robot

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Abstract— The purpose of this paper is to design a robot which is capable of detecting buried landmines and marking their locations, while enabling the operator to control the robot wirelessly from a distance. The ideas and concepts from the theoretical stages are shaped into the physical hardware components by fabrication of a prototype and then software programs are integrated into the system so as to test and experiment the concepts that had been developed. The designed robot is capable of detecting a buried mine, marking the exact location of the buried mine, and controlling itself from stepping over it and detonating the mine. The detection of the buried mine is done by using metal detectors since most land mines contain metal components.

Keywords— Rocker-bogie, Wireless control robot, Stair climbing, Transmit real time video, Detect Landmines

I. INTRODUCTION

The landmine crisis is globally alarming since there are present 500 million unexploded, buried mines in about 50 countries. Governments are looking into this situation seriously since landmines are claiming the limbs and lives of civilians every day [1]. The purpose of this project is to design a robot which is capable of detecting buried land mines and marking their locations, while enabling the operator to control the robot wirelessly from a distance. A land mine detection robot is needed to be designed to employ in peace support operations and in the clearance of contaminated areas. Also the robot shall be able to detect 50-90% of landmines (Anti-personnel mines) and mark the locations of the mines within a tolerance of 5cm. For the safety of the operator, the designed robot must be able to operate remotely, moreover, must be equipped with wireless data transmitting capabilities [2,3]. Landmines are easy-to-make, cheap and effective weapons that can be deployed easily over large areas to prevent enemy movements. Mines are often laid in groups, called mine fields, and are designed to prevent the enemy from passing through a certain area, or sometimes to force an enemy through a particular area. While more than 350 varieties of mines exist, they can be broken into two categories, namely, anti-personnel mines and anti-tank mines. Anti-personnel mines are designed to kill or injure enemy combatants. They are usually buried 10mm to 40mm beneath the soil and it requires about 9 kg minimum pressures to detonate them. The face diameter of most the anti-personal mines ranges from 5.6cm to 13.3 cm

II. LITERATURE SURVEY

1]‘Design and Implementation of a RF Controlled Robotic Environmental Survey Assistant System**’** by Md. Shamsul Alam, Insan Arafat Jamil, Khizir Mahmud and Najmul Islam published in 2014, focused on use of RF robots for environmental survey which involved data collection and logging and sensors to sense the hazardous compounds in the vicinity.

[2]‘Low Cost Radio frequency Controlled Robot for Environmental Cleaning**’** by M.Muthiah, Rk. Sathiendran, K.Nirmal published in the year 2015, used RF controlled robot for the cleaning in hazardous areas like Chemical Labs, Radiation Factories, etc. and even in home applications.

[3]‘Robust Stabilization of Wheeled Mobile Robots Moving on Uncertain Uneven Surface**’** focuses on stability of wheeled mobile robots (WMRs) which is more than legged robots. The control design is carried out for the dynamic model of unicycle, the most common and simplest among WMRs.

The need of such WMRs has been necessity of the age; they can be used in field operations such as for rescue and search applications. By this we can be sure that less human harm is done in rescue operations.

[4] ‘Robust Stabilization of Wheeled Mobile Robots Moving on Uncertain Uneven Surface**’** by Xiaocai Zhu, Guohua Dong and Dewen Hu and Zixing Cai published in 2006, used dynamics of the system to stabilize the robot (WMRs).

From the referred papers we have learned that the range of RF module is sufficient for low key applications, these applications can depend in the various field they are to be used. The components to be used can vary depending on the applications like cleaning purposes, Environmental surveillance, etc.

The accuracy, reliability, and flexibility can be taken in use for the RF robot. All the factors of stability, transmission of signals, cost-efficient robot are satisfied. The use of RF control can be helpful in the long range of activity and can be used efficiently.

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The disadvantages for the referred papers are that stability turns out to be the main problem due to obstacles in the travelling path.
Considering all the references the advantages are that:
RF based wheeled robot has been efficient for the use over uneven surfaces. Commercially these features can also be used for intelligent control systems. During the implementation of the system, a radio button will also be added to the GUI interface to make it a line follower robot.

III. DESIGN OF ROCKER BOGIE

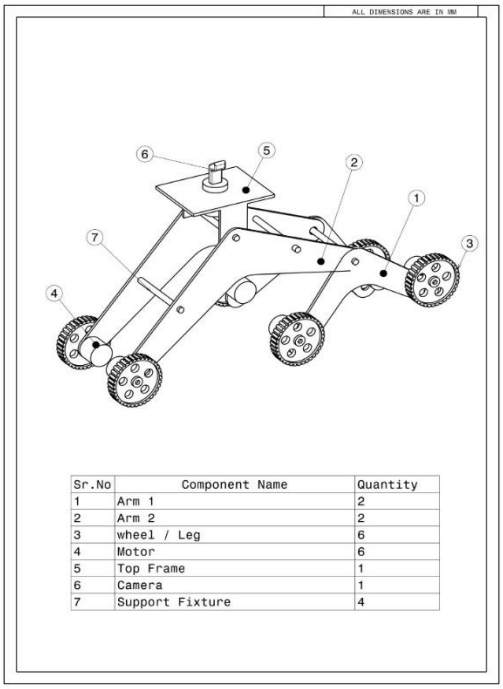
The important factor in manufacturing of Rocker-bogie mechanism is to determine the dimensions of rocker and bogie linkages and angles between them. The lengths and angles of this mechanism can be changed as per requirement. In the work aim is to manufacture the rocker bogie mechanism which can overcome the obstacles of 150 mm height (like stones, wooden blocks) and can climb over stairs of height 150 mm. Also another target is to climb any surface at an angle of 45˚. To achieve the above targets we had design the rocker-bogie model by assuming stair height 150 mm and length 370 mm.
Using Pythagoras theorem, find the dimensions of the model. It have both angles of linkages are 90˚.

A.Design Calculation

The objective of the mechanism is stair climbing overcoming obstacles In Its path. To achieve proper stair climbing the dimensions of linkages should be proper. Assume the stair height and length 150 mm and 370 mm respectively. To climb stairs with higher stability, it is required that only one pair of wheel should be in rising position at a time. Hence to find dimension of bogie linkages, first pair of wheels should be placed at horizontal position means at the end of the rising as And second pair should be placed just before the start of rising. There should be some distance between vertical edge of stair and second pair of wheel to striking of wheels.

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. 2.) 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



Sr.No	Component Name	Quantity
1	Arm 1	2
2	Arm 2	2
3	wheel / Leg	6
4	Motor	6
5	Top Frame	1
6	Camera	1
7	Support Fixture	4

fig 1. Rockerbogie Mechanism Architecture

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IV. WIRELESS COMMUNICATION

Communication systems play a major role in maintaining communication between humans or organizations or institutions or radio broadcasting programs via wired or wireless communication systems. To overcome disadvantages of wired communications, advancement in technology has resulted in the development of most advanced wireless communication systems including wireless radio frequency technology, infrared technology, GSM technology, and so on.

NASA recently started an ambitious exploration program of Mars. Pathfinder is the first rover explorer in this program. Future rovers will need to travel several kilometers over periods of months and manipulate rock and soil samples. They will also need to be somewhat autonomous. Rocker-bogie based rovers are likely candidates for these missions .The physics of these rovers is quite complex. To design and control these, analytical models of how the rover interacts with its environment are essential. Models are also needed for rover action planning. Simple mobility analysis of rocker-bogie vehicles have been developed and used for design evaluation. In the available published works, the rocker-bogie configuration is modeled as a planar system. MATLAB is used for programming.

Mankind has long sought improved methods of land transport. In recent years, practical mobile robots have been successfully used in environments such as factories, offices and hospitals as well as outdoors on prepared surfaces and terrain with minor irregularities. However, reliable mobility on extremely uneven terrain remains an elusive goal for man-made devices.

To have a secure foothold on the uneven surfaces and avoiding accidents due to imbalance wheeled robots can be used to travel freely on any type of terrain.

Devloped wireless communication system with following objectives

1.To design the block diagram and circuit related to system.
2.To simulate the circuit using diptrace software.
3.To create push buttons in GUI (graphical user interface) using MATLAB.
4.To write a program in MATLAB.
5.To design the PCB layout using suitable Software.
6.To test the developed system.

Software Analysis –Analyze the circuit on Diptrace, an simulated on Proteus and test the results for different component values, Microcontroller (AVR) programming using MATLAB.

Prototype Testing –Transmitting the data from MATLAB and receive on AVR controller and test results to go for final design

PCB layout and Itching – Layout by using Diptrace software, Itching by suitable method.

A.Circuit Diagram

As shown in above circuit diagram we proposed a system to provide direction to robot through matlab, and the command are transmitted to robot through RF Transreceiver.

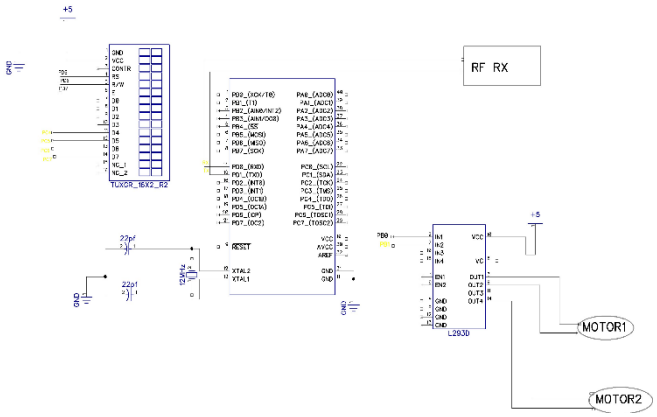

fig 2.Circuit Diagram

Along with that two Dc motor operated simultaneously with single L293D Motor Driver. LCD is used to visualize output of the application.

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B. HARDWARE

1.ATMEGA 16 –

ATMEGA16 IS High-performance, Low-power AVR® 8-bit Microcontroller, It has Advanced RISK Architecture, High Endurance Non-Volatile memory segment with 512 bytes EEPROM and 1K byte Internal SRAM.As well as it has Real time counter with seprate oscillator,4 PWM channel and operating voltage range is 4.5 v to 5.5 volt.

2.METAL SENSOR –

Metal Sensor is an electronic instrument which detects the presence of metal nearby. Metal detectors are useful for finding metal inclusions hidden within objects, or metal objects buried underground.As most of the landmine contain metal component so that we used metal detector in this system

3.RF TRANSRECIEVER-

This is an FSK Transceiver module, which is designed using the Chipcon IC(CC2500). It is a true single-chip transceiver. It is based on 3 wire digital serial interface and an entire Phase-Locked Loop (PLL) for precise local oscillator generation .so the frequency could be setting. It can use in UART/ NRZ / Manchester encoding / decoding. It is a high performance and low cost module. It gives 30 meters range without external antenna. In a typical system, this trans-receiver will be used together with a microcontroller.

4.L293D MOTOR DRIVE-

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. Dual H-bridge Motor Driver integrated circuit (IC).

V. RESULT

For many years walking machines have been thought of as rough-country vehicles, but recently a new impetus has come from the expansion of the need to handle radioactive materials in awkward environments and, in particular the repair and decommissioning of nuclear power stations. What is the case for building legged vehicle rather than wheeled or tracked ones? One reason is an interest in the legged locomotion itself, and the other is the superiority of legs over wheels or tracks.

Various tests were conducted to determine how the improved mechanism rover would perform against its predecessor designs by use of Negative moment VS. Obstacle Height and their responces were obtained and their graphs were plotted and comparison were made.Responce are shown in below fig 3 and fig 4.

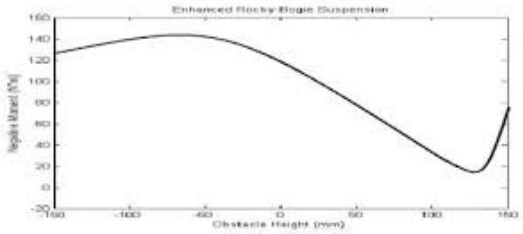

Fig 3. Response of rocker-bogie mechanism

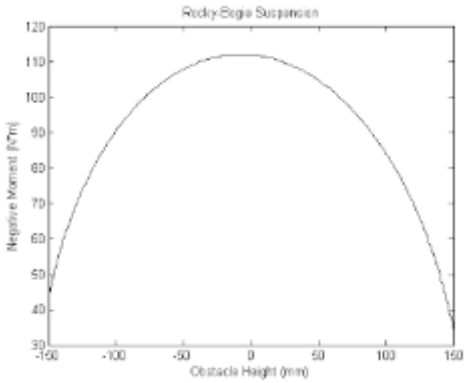

Fig 4. RBM Suspension against obstacles

VI. SPECIFICATION OF THE SYSTEM

1.RF module operating range is 30 meter with onboard antenna.
2. RF module operation temperature range: -40 to +85°c.
3. RF available frequency at: 2.4 to 2.483GHz.

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4. Operating voltage of ATmega16 is 4.5 to 5.5 V.
5. Speed grade for ATmega16 is 0 to 16MHz.
6. High performance, low power consumption AVR 8 bit microcontroller.

APPLICATION

The main application in military is when traveling on soft ground or rough terrain. The source of the most sustained interest in this application is the US army, which had supported the research in walking machines. In particular the OSU's Adaptive Suspension Vehicle is a prototype rough country vehicle. The objective of this project is to design a small, robust and highly maneuverable walking robot. It will be designed for walking on the different platforms like rough terrains, smooth surfaces, overcoming obstacles in its path
and climbing over obstacles of certain height, choosing different predetermined gaits and to have good stability, speed as well as payload capacity, which will be RF controlled robot to travel on uneven surface and detect landmines also transmit real time video. Along with that multiple areas of applications-

1. Military Transport
2. Minning
3. Planetry Exploration
4. Agriculture and Forestry
5. Mobile Robots In Artificial Intelligence

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