Advanced Stair Climbing Robot

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Abstract

The advances of robotic applications in human life, it is necessary to overcome natural and virtual obstacles such as stairs which are the most known obstacles to the motion of such robots. Several researches have been conducted toward the design of stair climbing and obstacle traversing robots during the past decade. A number of robots have robots have been built for climbing stairs and traversing obstacles, such as quadruped and hexapod robots. Although these robots can climb stairs and traverse obstacles, they do not have smooth motion on flat surfaces, which is due to the motion of their legs. Buehler built a hexapod robot that could ascend and descend stairs dynamically. There is an enormous variety of walking robots in the world today. Most of them have six legs to maintain good static stability, many have 8 legs for greater speed and higher load capacity and there are some that implement clever balancing algorithms which allow them to walk on two legs to move over sloping ground and to climb up and down stairs, like humans do Rough-terrain robot navigation has received a significant amount of attention recently, most prominently showcased to the broader public by the success of current Mars rover missions.

I. INTRODUCTION

Robot is a machine which is capable of carrying out a complex series of actions automatically. Specially one programmable by a computer. Robots can be guided by an external control device or the control may be embedded within. Robots have replaced humans in performing repetitive and dangerous tasks which humans prefer not to do,or are unable to do because of size limitations or which take place in extreme environment such as outer space or the bottom of sea. Robots are increasingly being integrated into working tasks to replace humans. They are currently used in many fields of applications including office, military tasks, hospital operations, industrial automation, security systems, dangerous environment and agriculture. Several types of mobile robots with different dimensions are designed for various robotic applications. The robot has been designed for the purpose of aiding rescue workers. Common situations that employ the robot are urban disasters, hostage situations, and explosions. The benefits of rescue robots to these operations include reduced personnel requirements, reduced fatigue, and access to unreachable areas. The robot is designed to go into slightly destroyed areas to find and help rescue people. The robot is even made to climb stairs and travel through fairly large amounts of rubbles. On the robot there will be a camera which is used to take video. robot is built to discover areas which people cannot reach. This robot is able to cope with stairs, very rough terrain ,and is able to move fast on flat ground. The robot is wirelessly connected to a transmitter/receiver circuit through RF remote control unit ensuring fast and reliable two-way communication. The robot body was prepared mechanically and electrical components were chosen to be suitable for the task of the robot. Walking robots have complex structures so that they are usually difficult to control and slower in speed. In that sense, the track mechanism has advantages in high speed driving and mobility under severe conditions. In spite of these merits, it consumes more energy than the others. Therefore it is needed to design a robot to overcome this drawback. Some recent researches are to develop a novel track mechanism with flexible configurations adaptive to various ground conditions.

II. LITERATURE SURVEY

Edwin Faa and Thanh Tung Le [1] describes a new design of a robot that is suitable for climbing up and down stairs. This design combines the advantage of using tracks and the robotic arm linkages to achieve robust climbing under the real-world conditions. Simulation models were initially used to develop the climbing sequences and later applied on a real prototype. System architecture of the robot is presented. All experimental and refinement of the climbing sequences was carried out using the prototype and the final product is an autonomous robot that is able to climb the stairs successfully.

Basil Hamed [2] had described disaster mitigation as well as for urban search and rescue missions, it is often necessary to place sensors or cameras into dangerous or inaccessible areas to get better situation awareness for the rescue personnel, before they enter a possibly dangerous area. Robots are predestined to this task, but the requirements for such mobile systems are demanding. They should be quick and agile and, at the same time, be able to deal with rough terrain and even to climb stairs. This paper presents the design and implementation of a feedback control system for an RF remote controlled stair climbing robot. The robot is controlled using PIC 16F877A.The paper presents a complete integrated control architecture and communication strategy for a system of reconfigurable robots that can climb stairs. Its mechanical design is suitable with back wheel to drive the robot over rubble, and large wheels in the front driven by dc motor for climbing stairs. The operator can monitor the robot operation by using video that are captured through a camera on the surface of the robot. The robot system is implemented by using Mikro C and visual basic programs. Experimental trials showed that the implementation of the behavior control systems was successfulSy.

Daniel M. Helmick, Stergios I. Roumeliotis2 , Michael C. McHenry3 , Larry Matthies4 [6] have been developed for the purpose of reconnaissance and/or search and rescue missions in buildings and cities. Autonomous stair climbing is a significant capability required for many of these missions. In this paper we present the design and implementation of a new set of estimation and control algorithms that increase the speed and effectiveness of stair climbing. We have developed: (i) a Kalman filter that fuses visual/laser data with inertial measurements and provides attitude estimates of improved accuracy at a high rate, and (ii) a physics based controller that minimizes the heading error and maximizes the effective velocity of the vehicle during stair climbing. Experimental results using a tracked vehicle validate the improved performance of this control and estimation scheme over previous approaches

III System Methodology

A lot of designs are available for wheel of stair climber , similar to a tri wheel designs is selected on the basis of strength, cost, easy to manufacture. Optimum design is selected by comparing the concepts with respect to optimum concept. Steering can be provided in future. Steps for making the Automation Staircase Climbing Robot:

- First design the wooden frame as per the dimensions with adjustable mechanism.
- The structure of the robot should be rigid.
- The four D.C motors are attached to the end of the frame.
- A 30v 1000mah battery is connected in to wheels through controller.
- The positive connection is upto12v.

Positive connection is for forward motion and negative connection is for backward motion and these connections are linked to circuit board for the robot motion.

The science and technology behind the engineering of robots has been a topic continuously being refined and researched over the last few decades. Modern day application such as drones for delivery as well as in search and rescue are becoming less science fiction and more reality. In fact, it is relatively affordable for the average consumer to purchase and utilize these for leisurely purposes. However, it remains that most terrestrial type robots that is those which are confined to the land's surface, as opposed to aquatic and aerial types which are developed for use in the ocean and air respectively, are frequently limited by their technology and ability to scale across uneven terrain. Few notable exceptions include the Mars Rover ranging from Sojourner to Curiosity. To implement a prototype robot model capable of climbing steps as proof of concept to traversing uneven terrain .To build a terrestrial robot able to climb a series of stair .To design a model capable of climbing a series of steps. To implement and test the model as a functional prototype

IV System Architecture

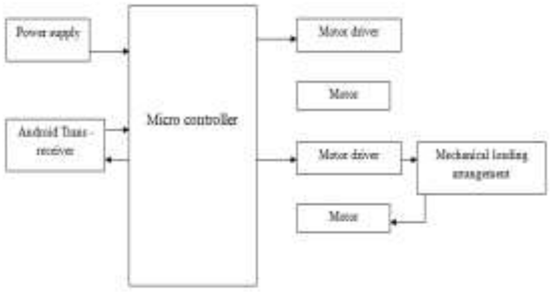

Fig Block diagram of system

Android based wireless stair climbing robot which is capable of climbing all terrains stairs in its path and which is wirelessly controlled through mobile using Bluetooth technology. The controlling device of the whole system is a microcontroller to which Bluetooth module; DC motors of robot are interfaced through a motor driver. Whenever the appropriate keys are pressed in the keypad of mobile, the data related to those keys will be transmitted over Bluetooth module using RS232 cable. This data will be received by Bluetooth module at robot and this data is fed as input to the controller. The controlling device of the whole system is a Microcontroller. Whenever the user presses any key from keypad of the mobile, the data related to that key is sent through m Bluetooth module interfaced to mobile. Whenever the appropriate keys are pressed in the keypad of mobile, the data related to those keys will be transmitted over Bluetooth module. This data will be received by Bluetooth module at robot and this data is fed as input to the controller. The Microcontroller checks the data with the program embedded in it and performs appropriate actions on the DC motors of the stair climbing robot. This data will be received by the Bluetooth module in the robot system and feds this to Microcontroller which judges the relevant task to the information received and acts accordingly. In the remote section of the robot at transmitter side we use mobile for all the basic control operations of the robot. When the user presses the relevant key from keypad of the mobile then the Bluetooth module should be connected to the mobile transmits the relevant command to the receiver unit wirelessly. The remote controlling section consists of mobile, Bluetooth transceiver module and a battery for the module to enable. User needs to follow the steps to connect hyper terminal of the mobile.

In the receiver section along with PIC microcontroller, Bluetooth module, 4 DC motor drivers are interfaced .If the user sends via serial communication i.e. Bluetooth module the climbing robot will move forward. Bluetooth module is connected at pin no B0 & B1 of the microcontroller. Microcontroller will receive signal and rotate the DC motors in forward direction. In the similar manner the appropriate keys given from mobile the combat robot performs the relevant operations like making robot movement forward, backward, left, right directions. We are using Relays as a DC motor driver. This data will be received by the Bluetooth module in the robot system and feds this as input to Microcontroller which judges the relevant task to the information received and acts accordingly. And for each and every DC motor one enable pin of the IC should be connected to the microcontroller. Here we are using 2 DC motors. Wheels are connected to the DC motors. The unique feature of the design is that the wheels can rotate independent of the motion of the entire tri wheel system as such.

Most of them have six legs to maintain good static stability, many have 8 legs for greater speed and higher load capacity and there are some that implement clever balancing algorithms which allow them to walk on two legs to move over sloping ground and to climb up and down stairs, like humans do Rough-terrain robot navigation has received a significant amount of attention recently, most prominently showcased to the broader public by the success of current Mars rover missions. In the future, increased autonomous capabilities will be required to accomplish ambitious planetary missions as well as a whole variety of Earth-bound tasks. This demand has led to the development of numerous approaches to solving the rough-terrain robot motion planning task. The common factor with all such research lies in the underlying characteristics of the rough terrain itself by the very nature of the task, binary obstacle definitions cannot be exclusively applied to rough- terrain motion planning. Each configuration of the robot operating on the terrain has a characteristic difficulty associated with its attainment. Depending on the properties of the problem being studied, different aspects of the robot/terrain interaction assume high relevance. These factors are consequently included in the terrain abstraction while other aspects are typically chosen to be omitted.

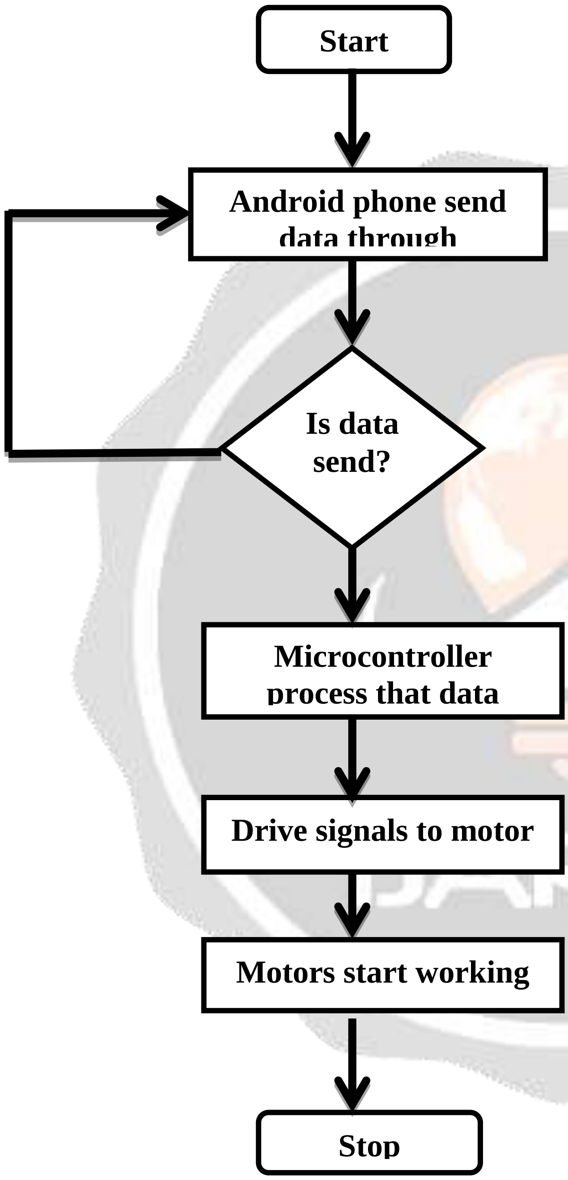

FIG. FLOWCHART OF SYSTEM

IV CONCLUSION

Thus we have implemented a prototype robot model capable of climbing steps. We have developed a terrestrial robot able to climb a series of stairs and tested the model as a functional prototype. We have developed the robot that is controlled very easily. Robot is climb steps of height of about 6 inches. Due to hardware limitations such as weight of the frame and design of wheel, the robot is able to climb a step of height limited to maximum of 6 inches. Microcontroller 89s52 is used in this robot in order to control the direction (right, left, forward and reverse) using 4 DC motors and H-bridge as driver. Then Bluetooth module (transmitter and receiver) is used in order to make the system wireless by using USB to UART cable. The control used was by making interface between controller and flash magic in both directions; sending data from computer to robot or vice versa. It takes video from a distance and navigate around objects that cannot climb. This is advantage over geared and leg based robots which have less productive due to poor mobility in a rough terrain. The robot is turn its direction of movement and can maneuver in all directions.

References

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