Stair Climbing Robot Using Star-Wheel Methodology

Balan.B , D.Sivakumar, Murali Krishna.K.B, Niranjan. M Lakshman Marthandam. R

Abstract: ***This project stair climbing robot exploits star-wheel methodology , which has the capability of ascending and descending stairs and traversing obstacles and flexible while climbing and declining sloped surfaces. The proposed system is a star-wheel based robot for physically challenged person. The important application of this robot is that, it is attached to the Wheel-Chair for carrying disabled persons over the stairs and obstacles. If the robot moves on flat surfaces and comes upon a stair or obstacle, the robot switches to Star-Wheels motion and one wheel of the Star-Wheels get fixed on one stair as a base and the Star-Wheels rotation will cause stair climbing. It allows the robot adapts itself with respect to the path curvature and prevents the shocks of the changes of path slope. Here the motion of the wheels is controlled by motors. ATmega microcontroller is used to interface Bluetooth and mobile application. The movement of the robot is controlled using mobile. application. HC-05 is a Bluetooth device (class 3) used for wireless transmission.***

Index Terms: Mobile Robot; Stair climbing Mechanism; Wheeled.

I. INTRODUCTION

The legs are the necessary part of the human body. As per the census 2011, In India out of the 121Cr population, .2.68Cr persons are disabled which is 2.21% of the total population. Around 5.4 million peoples have disability in movement. In cities it`s difficult to find buildings without stairs which increase the suffering of disable people making them indeed need assistant every move which decrease their chances to live normal activities. At the other side it is not convenient and also financially not easy to fit electric lifts everywhere. Therefore stair act as a repetitive obstacle for disabled restrict their ability to move without assistant. The prime motive of this project is to design and develop mech-anism that makes the disable person climb stairs safely without assistant. Stair climbers

Revised Manuscript Received on December 22, 2018.

Balan.B , Associate Professor, Department of ECE,Easwari Engineering college, Chennai, India,
D.Sivakumar , Professor, Department of ECE,Easwari Engineering college, Chennai, India
Marthandam.R, U.G.Students,Department of ECE, Easwari Engineering College, Chennai, India
balan.com@gmail.com & dgsivakumar@gmail.com

as a mean of transportation tool plays an important role in the life of people who are old or disabled easily access places including stairs. This robot moves smoothly on both flat surfaces and stairs in the path of the movement disabled persons. It also has an functionality for controlling the robot using Bluetooth[9].

II. EXISTING SYSTEM

The inability to climb coarse walls, frictional resistance and abrasion of suckers, and poor obstacle-surmounting ability are some of the technical problems faced by traditional robots which use vacuum suckers. A new negative pressure adsorption mechanism is used in the design of the robot. This mechanism generates and maintains negative pressure and adsorption force by using the air's rotational inertia effect; therefore, the structure incorporating this mechanism is called the electrically activated rotational-flow adsorption unit. The most important characteristic of the adsorption unit is that it can function without being in contact with the wall, which fundamentally solves these technical problems associated with traditional climbing robots. For improving the robots load ability and obstacle surmounting ability, it has been designed a square shaped rotational-flow absorption unit and soft skirt structure. These have been tested in the actual wall and results shows that the robot can move stably. Some robots have been designed for traversing through stairs and obstacles by researchers such as quadruped and hexapod robots. Although these robots can traverse stairs and obstacles, but they usually don't have smooth manoeuvring on flat surfaces due to their motion on legs [1]. On the other side wheeled and leg-wheeled robots have been introduced that they can climb only one stair [6].

III. PROPOSED SYSTEM

If the robots climb, decline through a sloped path, the robot switches to star-wheels motion. The star-wheels can rotate freely around their axes. One of the wheels of the star-wheel get fixed on one stair as a base and the rotation of the star-wheels effects in stair climbing. It allows the robot adapts itself with respect to path curvature and prevents the shocks of changes of path slope.

Published By:
Blue Eyes Intelligence Engineering &
Sciences Publication

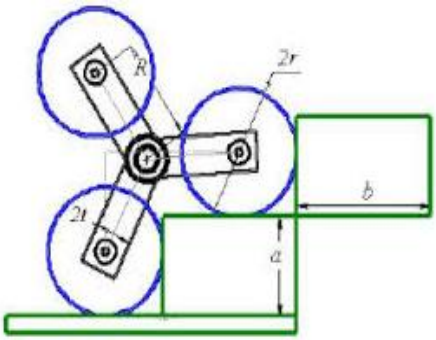


Fig.1: Tri-Star Wheel

Also it enables all the eight wheels to have firm contact with the ground and ensure that the wheels and ground are intact at all the stages of traversing period. It should be noted that the material of wheels and stairs are Rubber. So we can attach the robot to the wheel chair which carries the movement disabled person to move through stairs without help of anyone in the home or in any other places where elevator facilities are not available. This makes them to move around upstair and downstair without seeking help from others.

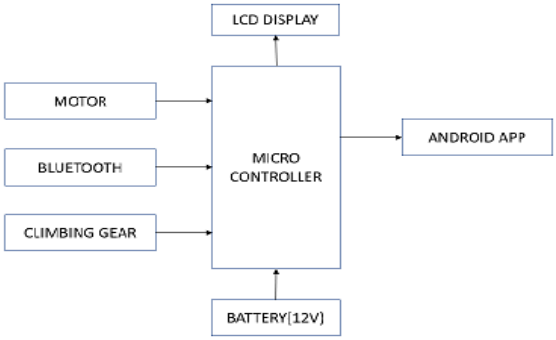


Fig.2: Block diagram of the entire system

A. Power Supply :

A power supply minimum of 12V is required for the robot to run effectively. The input power source provided by a battery, powerbank, micro USB. We use Amptek Battery (12V 1.3AH/20HR) rechargeable battery. Its composition is lead acid. Standby voltage use is about 13.5-13.8V. !4.4-15V is the voltage range of cyclic use. Initial current of this battery is less than 0.39A.

B. AT mega controller:

ATmega 328P is one of single chip microcontroller created by Atmel in the Advanced Virtual RISC (AVR) family. It is a microcontroller with 8-bit with inbuilt 32K flash memory, 1K EEPROM, and 2K internal SRAM. This facilitates an autonomous systems with low-power, low-cost microcontroller operates between 1.8-5.5 volts.

C. Bluetooth:

Bluetooth uses wireless technology for transferring data within short distance between fixed and mobile equipment. It uses radiowaves for transmission. Here, we are using HC-05 bluetooth module for interfacing between mobile application and ATmega microcontroller. Since the coverage is less than 10meters we use Class-3 type bluetooth is preferred here.

D. Display:

A 16x2 LCD display is used here. This shows the current motion of the robot either in forward motion or backward motion.

E. Motor:

A DC motor is used which helps us to convert electrical energy to mechanical energy. We use Johnson motor to pull up the entire load. Totally, there are 4 motors are used for the movement of robot. The minimum supply needed for the motors is 12V. So that the maximum rpm is gained [8].

F. Relay Module :

The relay switch module ensures electrical isolation which enable to turn on or off a circuit. This switch isolates voltage and/or current much higher than a microcontroller could handle.The low voltage circuit operated by the microcontroller and the high power circuit are electrically isolated using this switch. The circuits are protected from each other.Blue cubes are 2 channels in the relay module. This module should be powered with 5V or 3.3V sometimes. There are three modes named NC(normally close), COM(common), and NO(normally open) in each channel in the module.From the input signal trigger mode, the jumper cap is been placed at high level effective mode which ‘closes’ the normally open (NO) switch at high level input and at low level effective mode operates the same with low level input

G. Material Used:

Acrylic is a type of fabric, fiber, or paint that made from acrylic acid. The weight of acrylic is half the weight of glass. The thickness of acrylic is 8mm. Eventhough it is costlier than wood, acrylic is used because the damage to material is very less when compared to wood while

Climbing the stairs. The material used to make acrylic makes it durable than wood. -10°c to +55°C is the temperature range of this material.

H. Gear:

We have two types of gear here which have the same dimensions but differ in the inner diameter: Wheel gear that transmit power to wheel and gear that transmit power from motor to the middle gear and One for the power transmission from the middle gear to the wheel gear. Totally, there are seven gears. There is one central gear which controls other 6 gears. The 6 gears are made into pairs and they are fixed with central gears with equal separation of approximately 120 degree. The central gear is connected to the motor. The star has 3 wheels connected to the gear and there are totally 4 star arrangement, and 12 wheels entirely. The spur gear and the worm gear are used simultaneously to increase torque.

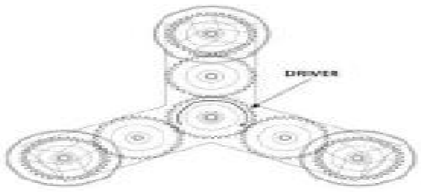
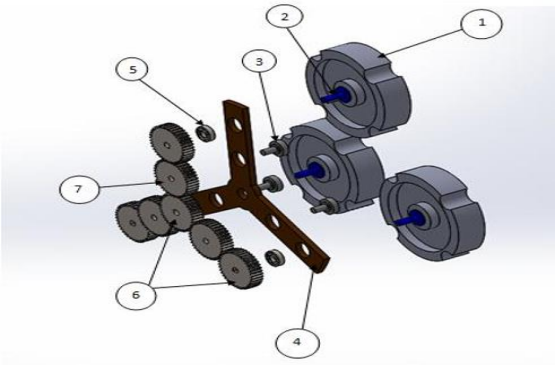


Fig.3: Star Wheel Frame



N0.	Name
1	Wheel
2	Wheel & gear Shaft
3	middle gears shaft
4	Holder
5	Bearing
6	Gears with key seat
7	Middle gear

Fig.4:Star wheel components

IV. SOFTWARE USED:

- ARDUINO IDE (Integrated Development Environment) is used here which helps to write computer code and dump the code into the physical board [7]. It is a open source software. It mainly consists of two parts: Editor and Compiler. Editor is used for code writing, where compiling and uploading is done using compiler.

- An open source web application called MIT APP INVENTOR originally provided by google allows to create software application for the android operating system. To run an application on android devices, it allows users to drag and drop visual objects. It allows you to select the components for your application and allows to specify how visually the components should behave.

V. CONCLUSION:

This project aimed to develop a mechanism for climbing stair using star wheel system which its main idea was making the wheels rolling within motion in flat surfaces while in climbing motion the whole system will roll together. Gear system was chosen as transmission system. The design and modeling of a mobile robot with Wheel-Based motion, is inspired from legs of human beings while climbing and descending stairs. Due to its star wheel motion, it has the advantage of ascending, descending and traversing with flexibility toward uphill, downhill and slope surfaces. . Furthermore, on flat surfaces it has smooth and fast motion which is due to its wheels motion. It shows that the robot can be used for any terrain a human can go. It can also be used for space researchers as a Spacecraft or war regions identification or unknown terrains.

VI. FUTURE ADVANCEMENTS:

Researches on climbing and descending on a different range of stairs, obstacles, models, inclinations and surface conditions are ongoing. This is the basic needed advancement. There is no left-right motion and also gyrometer should be installed in this robot remains same while moving uphill, downhill. Researches on climbing and descending on a different range of stairs, obstacles, models, inclinations and surface conditions are ongoing. This is the basic needed advancement. There is no left-right motion and also gyrometer should be installed in this robot, so that the balance in the center of the robot remains same while moving uphill, downhill or traversing.

REFERENCES:

1. M. Buehler, Dynamic Locomotion with One, Four and Six-Legged Robots , Invited Paper, Journal of the Robotics Society of Japan, 20(3), (2002) 15-20

2. E. Z. Moore, D. Campbell, F. Grimminger, and M. Buehler, Reliable Stair Climbing in the Simple Hexapod 'RHex', IEEE Int. Conf. on Robotics and Automation (ICRA), Vol 3, pp 2222-2227, Washington, D.C., USA, May 11-15, 2002

3. E.Z. Moore and M. Buehler, Stable Stair Climbing in a Simple Hexapod, 4th Int. Conf. on Climbing and Walking Robots, Karlsruhe, Germany, September 24 - 26 , 2001.

4. U. Saranli, M. Buehler, and D. E. Koditschek, RHex: A Simple and Highly Mobile Hexapod Robot, Int. J. Robotics Research, 20(7):616-631, July 2001

5. R. Altendorfer, E. Z. Moore, H. Komsuoglu, M. Buehler, H. B. Brown Jr., D. McMordie, U. Saranli, R. Full, D. E. Koditschek, RHex: A Biologically Inspired Hexapod Runner, Autonomous Robots, 11:207-213, 2001

6. H. Raibert, Legged Robots that Balance, MIT Press, Cambridge, MA, 1986

7. Eiji KOYANAGI and Shin'ich YUTA, A development of a six wheel vehicle for indoor and outdoor environment, Proceedings of the International Conference on Field and Service Robotics, pp.52-63, 1999-8, Pittsburgh

8. Aarne Halme, Ilkka Leppnen, Miso Montonen, Sami Ylnen, Robot motion by simultaneously wheel and leg propulsion, Automation Technology Laboratory, Helsinki University of Technology, PL 5400, 02015 HUT, Finland , 2001

9. Venkat Krovi, Vijay Kumar, Modeling and Control of a Hybrid Locomotion System, ASME Journal of Mechanical Design, Vol. 121, No. 3, pp. 448-455, September 1999