International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 03 | Mar-2016 www.irjet.net p-ISSN: 2395-0072

Wireless Staircase Climbing Robot with Adaptive Morphing System

Suraj Shinde [1], Supriya Ayarekar [2], Pooja Chavan [3], Nikita Chougule [4], Tejaswini Konduskar [5]

[1] *Assistant Professor, Dept. of E&TC Engg., SETI, Maharashtra, India*
[2345] *Student, Dept. of E&TC Engg., SETI, Maharashtra, India*

Abstract - In the present scenario the application of robots is quite common to reduce the human effort in several areas. However the main disadvantage of the rugged terrain robots is their compatibility limited to non elevated terrains. The stair climbing robots are used for elevated terrains like stairs, slopes, etc or for similar different applications. To overcome the problem, we have developed an adjustable stair climbing robot to climb the stairs up and down according to the dimensions of the staircase by using adjustable frame. The main features of our robot include the platform, which is attached to the adjustable frame, to carry the materials up and down as per the motor capacity. The main application of this robot is to carry materials on the platform during rescue operations.

Key Words: *Adjustable frame, Staircase, Circuit board, Joystick, Robot Wheels, Actuators.*

1. Introduction

Adjustable stair climbing robot is one of the most attractive performances of robot in legged and wheeled configuration. Developments have been made on various kinds of stair climbers, considering how to make its climbing ability higher and its mechanical complexity reasonable and practical. However every research needs a proper trade-off between all the essential factors to make the product user-friendly. Reducing body weight and energy consumption is one of the major aspects in this area. In this paper we would like to propose some solutions to realize stair climbing mechanism. Further, we have discussed about development of adjustable high-grip mover, which we think one of the best solutions as the stair climber. Major areas of our interest concern the mechanism, machine used to implement the robot application and importantly robotics. A mechanism is a combination of rigid or restraining bodies, so shaped and connected, that they move upon each other with definite relative motion. A machine is a collection of mechanisms which transmits force from the source of power to the load thus performing useful mechanical work. Robotics is the area of automation which integrates the technology in variegated fields like mechanisms, sensors & electronic control systems, artificial intelligence and embedded systems.

1.1 WHEELED ROBOTS

Wheeled robots usually have to resort to mechanical extensions to overcome stairs. One application of such a technique is inpatient rehabilitation, where stair climbing could greatly enhance mobility, and thus quality of life, of people confined to wheelchairs. Lawn and Shiatsu have presented a stair-climbing wheelchair using two (forward and rear) articulated wheel clusters attached to movable appendages. The robot is equipped with step-contact sensors, but relies on user steering and is thus only semi-autonomous. [6]

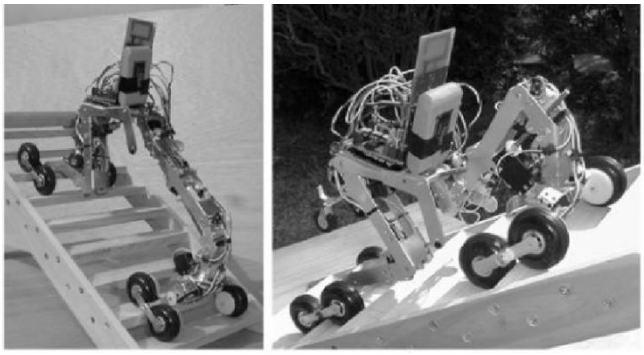


Fig1. weeled robot

1.2 LEGGED ROBOTS

Figliolini and Ceccarelli have proposed the architecture of the bipedal robot EP-WAR2, that uses electro pneumatic actuators and suction cups for locomotion. In order to climb stairs, the robot relies on an open-loop control algorithm implemented as a finite-state machine. The main limitation of the approach is that operating in a different staircase necessitates manual recalibration. [6]

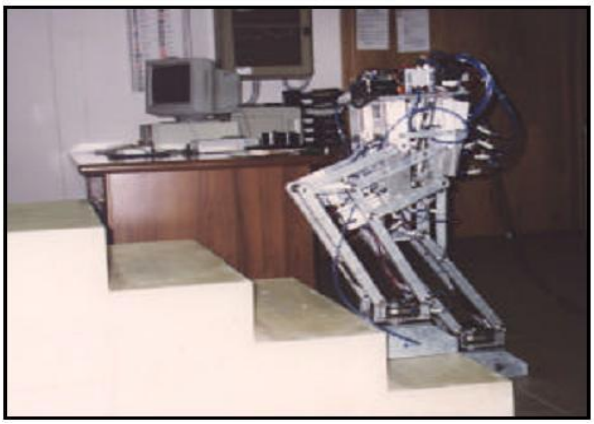


Fig2.legged robot

1.3 TRACKED ROBOTS

Tracked robots have a larger ground contact surface than wheeled vehicles and are more stable than bipeds due to their low centre of gravity. Liu et al

derived the fundamental dynamics of the stair-climbing process for a tracked robotic element, analyzing the different phases of riser climbing, nose crossing, nose line climbing and the effects of grouser bars or cleats. The analysis is limited to 2D, and slippage, shocks, and intermittent loss of track-surface contact, phenomena that are commonly encountered during stair climbing, are neglected.[7]

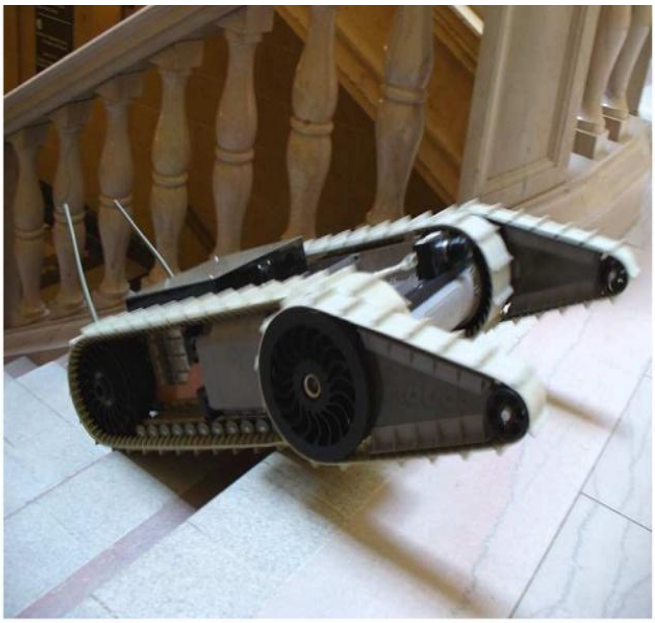


fig. 3. tracked robot

2. SYSTEM DESIGN

Wireless staircase climbing robot with adaptive morphing system

Wireless staircase climbing robot with adaptive morphing system is a prototype depicting the technical advancements possible in it. It first senses the change in movement of joystick. The joystick used produces a change in the value of resistance when bent. This joystick is used for various movements of robots such as forward, backward, right, left as well as for the movement of actuator.

There are main two systems viz. human interface and robot. The human interface is the circuit which senses the movement of joystick, those sensed readings are transmitted wirelessly by encrypting it with help of microcontroller. At the receiver of robot the received data is decrypted and given to actuators and thus robot moves as per the joystick movement.

This design of robot can work in conditions which are not portable for human beings. This robot has the capability to move around in its environment and is not fixed to one physical location. The system is much effective as it gives the human interface to control the mobile robot by staying in same place. In future for efficient establishment of an overseas communication between user interface and the robot, we can use satellite communication.

Features of Project:

1. The main feature of this project is it can save travelling expenses as well as time whenever we are supposed to visit some place for work.
2. As it works on real time analysis, we come to know the current scenario at the robot side. This information helps us to operate the robot efficiently.
3. We can implement this project in highly sensitive area or in military operations to avoid risk of human loss.
4. This project can lead the new way to enhance the industrial automation

3. Robot Skeleton:

A robot is a mechanical or virtual artificial agent, usually an electro-mechanical machine that is guided by a computer program or electronic circuitry. Robots can be autonomous or semi-autonomous and range from humanoids to industrial robots. By mimicking a lifelike appearance or automating movements, a robot may convey a sense of intelligence or thought of its own.

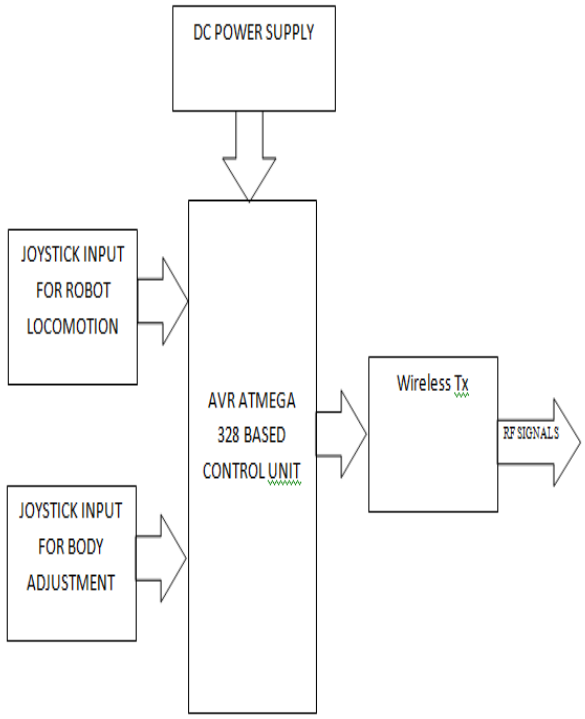
Robots have replaced humans in the assistance of due to size limitations, or even those such as in outer space or at the bottom of the sea where humans could not survive the extreme environments.

Designing of the robot frame is an important factor as it extensively affects the balancing and working of the robot. We have used joystick as robot base and have supported the locomotion and actuator. To reduce the whole weight of the robot aluminum is best found material and thus we used the aluminum as core material for robot gripper and also the frame-work of the robot.

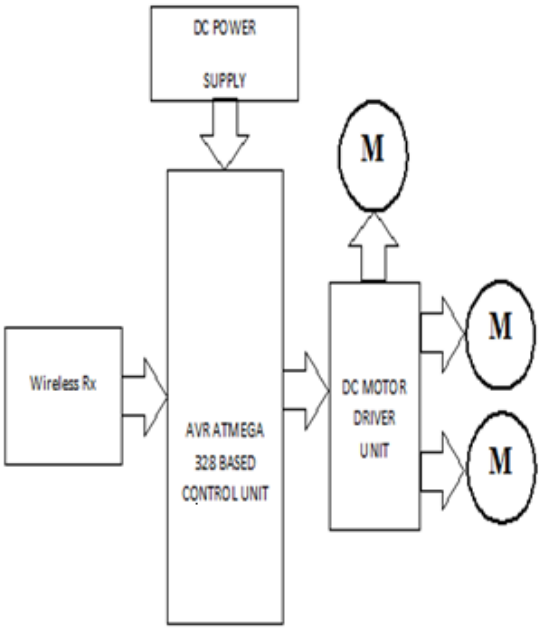
4. General Block Diagram:

Here first of all we have used power supply of +5v for microcontroller and +12v for the Johnsons motor. Microcontroller328 is the heart of our project. The inputs are taken from the joystick which is given to microcontroller328. These signals are then transmitted wirelessly to the receiver side.

4.1 Transmitter:



4.2 Receiver:



The signals are received by the RF module which are given to the microcontroller. According to the input signals the motors will run.

Power supply :

We require power for proper and efficient working of all the modules. We have used 5 V and 12 V supplies. Also we have used batteries of 12V, 1.2 Ah and 12V, 7.5Ah on robot side.

Microcontroller :

Microcontroller is the brain of project which encrypts and decrypts the transmitted and received signals for efficient controlling of the robot. We have used ATmega 328 microcontroller.

Actuators:

We have used actuators such as servo motors and DC motors to provide movement for the robot.

Transceiver :

The transceiver module is used for duplex wireless communication between the robot and the user. We have used nRF24L01 transceiver module for wireless communication.

5. Implementation

5.1 Transceiver Module :-

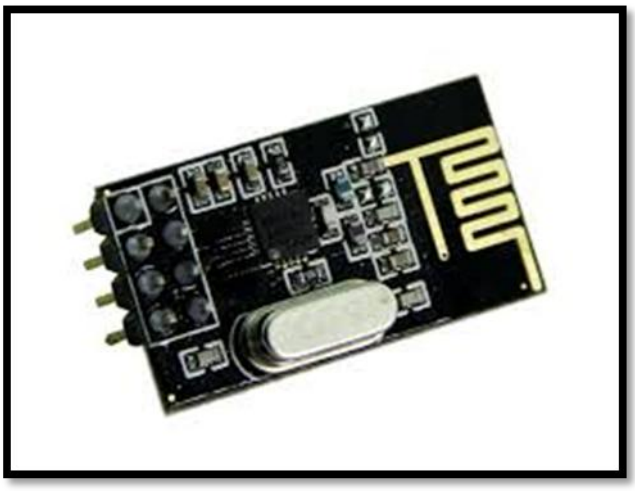


Fig.4. RF24L01 transceiver module

The nRF24l01 is single chip 2.4GHz transceiver with an embedded baseband protocol engine, suitable for ultra-low power wireless applications. The Nrf24l01+ is designed for operation in the world wide ISM frequency band at 2.400 – 2.4835GHz.

To design a radio system with the Nrf24l01+, you need an MCU and a few external passive components.

These are a series of 2.24 GHz radio modules that are all based on the Nordic Semiconductor nRF24L01+ chip.

The low power short range (200 feet or so) transceiver is available on a board with Arduino interface and built in Antenna. Transceiver range is very dependent on the situation and is much more with clear line-of-sight outdoors than indoors with effects of walls and materials. The usual distance quoted by different suppliers for the low power version module with the single chip is 200 feet or 100 meters.

Table 3.1. Pin connections of nRF24L01

Pins	NRF Pins	Connected to Arduino pins
1	GND	GND
2	VCC	3.3V
3	CE	PIN 9
4	CSN	PIN 10
5	SCK	PIN 13
6	MOSI	PIN 11
7	MISO	PIN 12
8	Unused	

- **Features :-**

1. Worldwide 2.4 GHz ISM band operation
2. On chip voltage regulator
3. 1.9 V to 3.6 V supply range
4. Ultra low power operation
5. 16 MHz crystal

5.2 Motor-

10RPM 12V DC geared motors for robotics applications. It gives a massive torque of 10Kgcm. The motor comes with metal gearbox and off centered shaft. Shaft has a metal bushing for wear resistance.

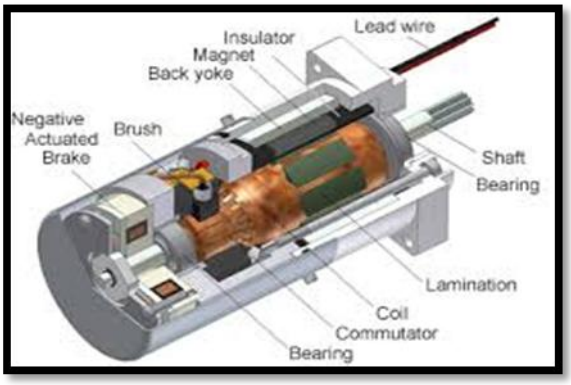
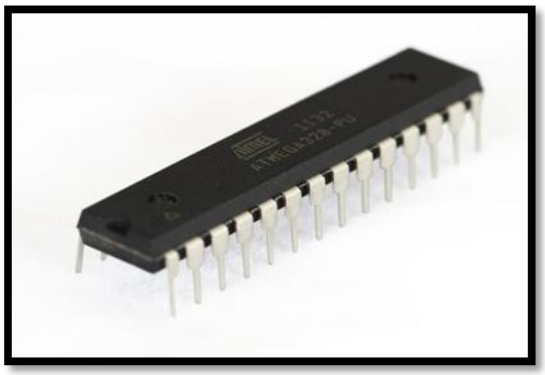


Fig.5. Johnsons dc geared motor

- **Features:-**

1. 10RPM 12V DC motors with Metal Gearbox
2. 18000 RPM base motor
3. 6mm shaft diameter
4. Gearbox diameter 37 mm.
5. Motor Diameter 28.5 mm
6. Length 63 mm without shaft
7. Shaft length 15mm
8. 300gm weight
9. 10kgcm torque
10. No load
11. current = 800mA (Max), Load current = up to 9.5 A(Max)

5.3 Microcontroller :



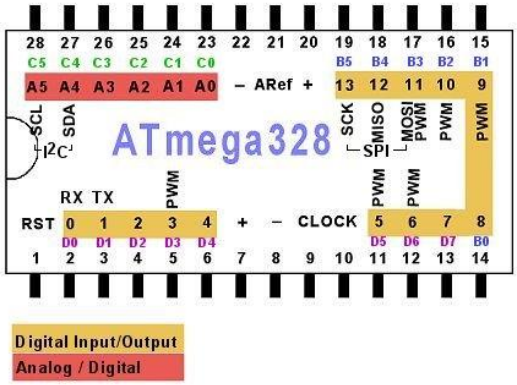


Fig. 6. ATmega328 Microcontroller

Microcontroller is heart of the system. There are different types of microcontrollers with different features. We have used ATmega328 microcontroller. It is high performance 8 bit microcontroller. The ATmega328P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328P achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

Features:-

1. 28 pin IC
2. 32 x 8 general purpose registers
3. It has 3 ports B, C and D.
4. In-system 32 KB programmable flash memory
5. In built ADC and timer
1. 2 KB RAM and 1 KB EEPROM
2. Temperature = -40º to 85º
3. Operating voltage = 1.8 V to 5.5 V

5.4 Joystick :

Joystick is an input device commonly used to control things according to application. Joystick consist of a base and a stick that can be moved in any direction. The joystick can also be moved from left to right and vice versa. Because of the flexible movements a joystick allows, it can provide much greater control than the keyboard.

Fig.7.Joystick

The joystick is used on user section to control the motion of robot i.e. movement of robot forward, backward, left and right. Analog joystick has two variable resistors for two axis. Each variable resistor has three pins, two extreme pins are connected to Vcc(5v in our case) and ground. The center pin is the output pin. The output voltage is between Vcc and GND depending on the position of stick. By measuring the voltage output of two variable resister from which the joystick is built, we can determine the position of stick in x and y axis. The joystick has springs to return thumb stick in to center position. So potentiometers are also centered. If there are 10k potentiometers used, then each value is centered at about 5k. So if we use 10-bit ADC, we get center point at analog value 512.

Table 3.3.4 Pin connections of Joystick

Pins	Description
GND	Ground pin
VCC	+5V DC Supply
Rx	X Axis
Ry	Y Axis
SW	Push button

6. RESULTS AND CONCLUSION

This wireless robotic system is developed to perform a specific task using a humanoid robot, which is controlled by a respective user, who is far apart. This system analyzes the input signals received from various sensors at the user side such as joystick etc. and follow the user defined action according to these inputs. The Johnsons motors of base wheels are controlled by the joystick. The joystick is basically a two potentiometer assembly with a push button at the center. The joystick readings are obtained in x and y axis. Thus while programming, we can assign the forward, reverse, left or right as function keys for joystick.

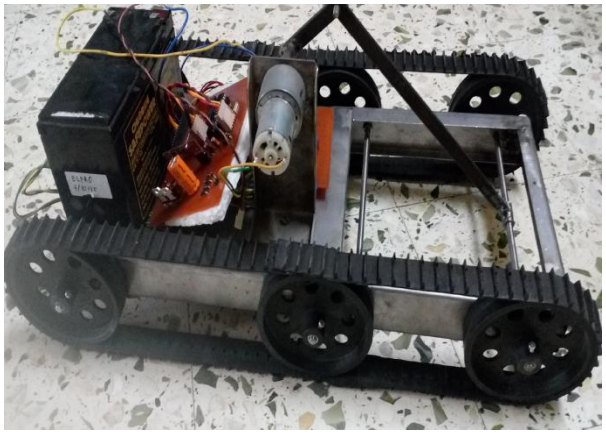


Fig.8.Wireless staircase climbing robot

Thus the clockwise or anticlockwise rotation of DC motor strictly depends of signals received from joystick. The Johnsons base motor has a speed of 1800rpm motor has maximum speed of 10 RPM providing torque of 7-10

kg. In order to control the speed of the robot, we have used a potentiometer.

REFERENCES

[1] M. Lawn and T. Shiatsu, "Modeling of a stair-climbing wheelchair mechanism with high single-step capability," IEEE Transactions on Neural Systems and Rehabilitation Engineering, vol. 11, no. 3, pp. 323–332, Sept. 2003

[2] G. Figliolini and M. Ceccarelli, "Climbing stairs with EP-WAR2 biped robot," in Proc. IEEE International Conference on Robotics and Automation (ICRA), vol. 4, Seoul, Korea, 2001, pp. 4116–4121

[3] J. Liu, Y. Wang, S. Ma, and B. Li, "Analysis of stairs-climbing ability for a tracked reconfigurable modular robot," in Proc. IEEE International Workshop on Safety, Security and Rescue Robotics, Kobe, Japan, June2005, pp. 53–38

[4] R. C. Luo, K. L. Su, "A multi agent multi sensor based real-time sensory control system for intelligent security robot" IEEE International Conference on Robotics and Automation, vol. 2, 2003, pp.2394 – 2399.

[5] Sandeep H. Deshmukh, Sakthivel P. & Srikanth Sankaran, "Computer Aided Design and Interfacing Of EOT Crane" in the Proc. of Global Conference on Production and Industrial Engineering ,National Institute of Technology, Jalandhar, 2007, Session 4A , pp 1-6

[6] Jeyabalaji C1, Vimalkhanna V2, AvinashilingamN2, Mohamed Zeeshan M A3and Harish Kumar N3 1R.M.D. Engineering College, Department of Electronics and Communication Engineering,Kavaraipettai,Tamilnadu,India. 2R.M.D. Engineering College, Department of Computer Science and Engineering, Kavaraipettai,Tamilnadu, India. St Joseph's College of Engineering, Department of Electronics and Communication Engineering, Panapaakkam, Tamilnadu, India.

[7] K. Narendra Kumar1, A. Gopichand2, M. Gopala Anjaneyulu3, B. Gopi Krishna4 1 Assistant Professor, 2Associate Professor, 3, 4Student, 1, 2, 3, 4Department of Mechanical Engineering, Swarnandhra College of Engineering and Technology, Narsapur, Andhra Pradesh, India- 534275 narendra.or.kumar@gmail.com, allakagopichand@gmail.com, gopala.anji@gmail.com, bgk303@gmail.com