RESEARCH ARTICLE OPEN ACCESS

Design of Low Cost Stair Climbing Robot Using Arduino

Jeyabalaji C[1], Vimalkhanna V[2], AvinashilingamN[2], Mohamed Zeeshan M A[3]and Harish Kumar N[3]

[1]R.M.D. Engineering College, Department of Electronics and Communication Engineering,Kavaraipettai,Tamilnadu,India.

[2]R.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.

Abstract:
Since the invention of the wheel, Man has sought to reduce effort to get things done easily. Ultimately, it has resulted in the invention of the Robot, an Engineering Marvel. Up until now, the biggest factor that hampers wide proliferation of robots is locomotion and maneuverability. They are not dynamic enough to conform even to the most commonplace terrain such as stairs. To overcome this, we are proposing a stair climbing robot that looks a lot like the human leg and can adjust itself according to the height of the step. But, we are currently developing a unit to carry payload of about 4 Kg. The automatic adjustment in the robot according to the height of the stair is done by connecting an Android device that has an application programmed in OpenCV with an Arduino in Host mode. The Android Device uses it camera to calculate the height of the stair and sends it to the Arduino for further calculation. This design employs an Arduino Mega ADK 2560 board to control the robot and other home fabricated custom PCB to interface it with the Arduino Board. The bot is powered by Li-Ion batteries and Servo motors.

Keywords: Robot, Arduino, Climbing Robot, OpenCV.

I. INTRODUCTION

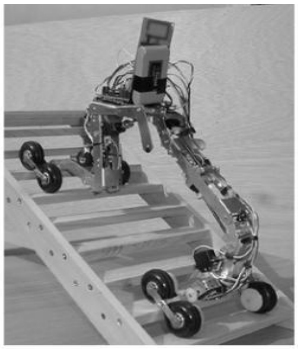
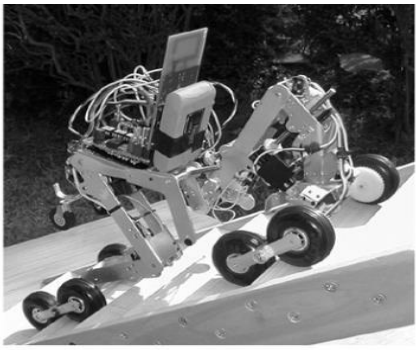
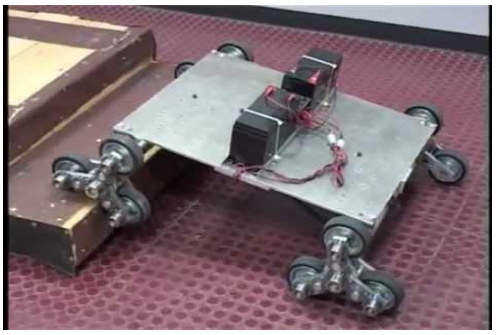
The sight of a robot climbing stairs is one to behold. There has been extensive research and development with a drive to improve these kinds of robots with respect to factors like cost, climbing ability, reasonability and practicality of its mechanical complexity. Further it aims to lower body weight, reduce the power consumption while also increasing the payload carrying capacity. Robots employ different types of mechanisms for their locomotion.The synthesis of mechanisms is the very first step in any robot design depending upon its application.Each type of mechanism has its own strengths on which it can capitalize. Some of them usewheels, some use legs and so on**.** With the passing of time and advanced research, technology has gone mobile. The model that we have developed can be programmed and itsmovements can be controlled by an android device using OpenCV architecture.

II. LOCOMOTIVE MECHANISM

There have been a lot of developments and innovations in stair climbing robots with different locomotive mechanisms. They can either move using legs or using wheels

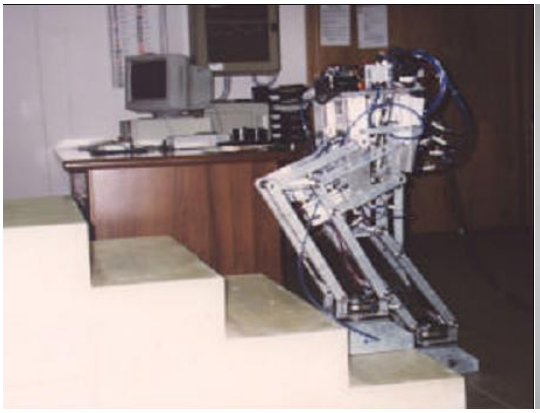
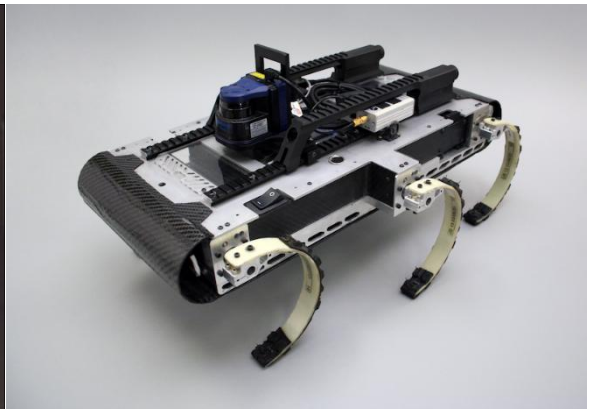
2.1 WHEELED ROBOTS

Wheeled robots usually have to use mechanical concepts to climb stairs. The advantage of these kind of stair climbers is that they have enhanced mobility and a longer life. These robots use step sensors to efficiently calculate the height of each step and the number of steps it climbs. The main drawback in the robots using this system is that they are semi-autonomous.

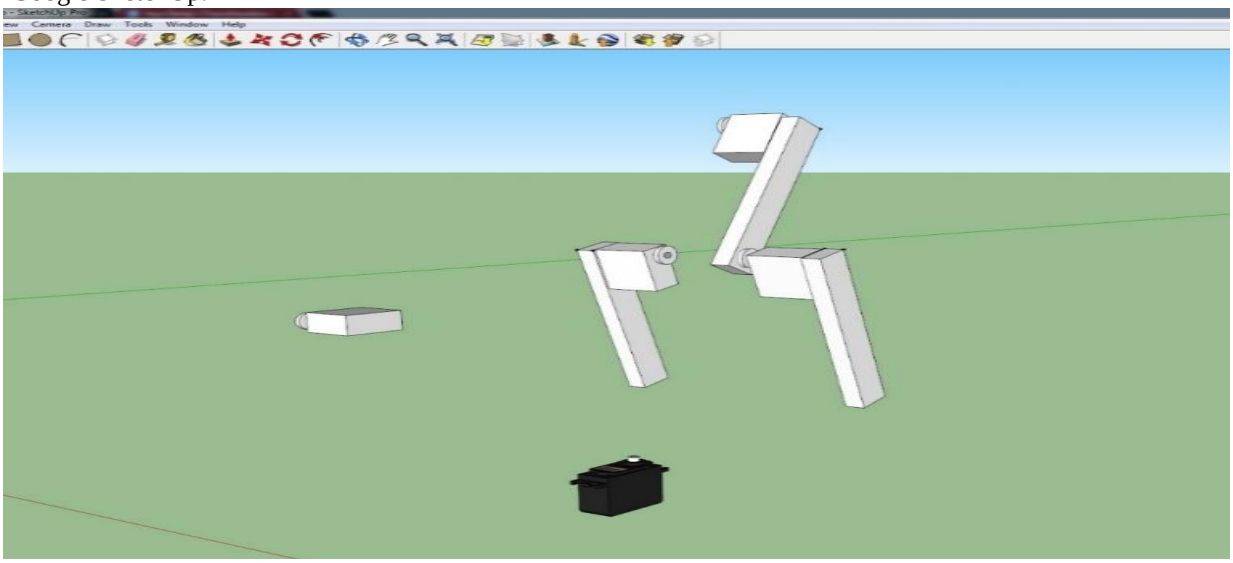
2.2 LEGGED ROBOTS

The traditional legged stair climbers use pneumatic actuators and suction cups for motion. These are finite state machines and require recalibration under different stair case configurations. The drawbacks of the robots using this system is usually the cost of the actuators.

III. DESIGN OF ROBOT

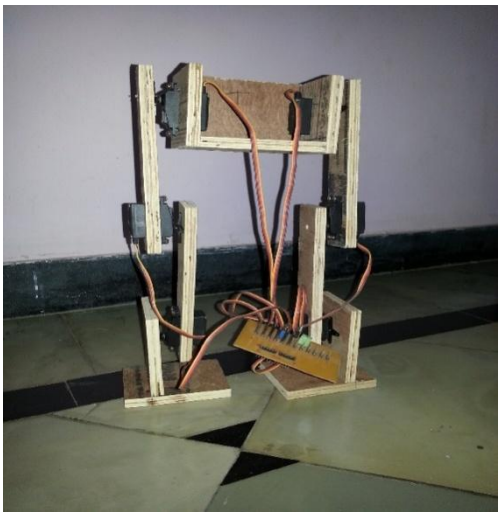
Presently, we have designed the robot using Arduino and few servo motors. The model is implemented using Google SketchUp.

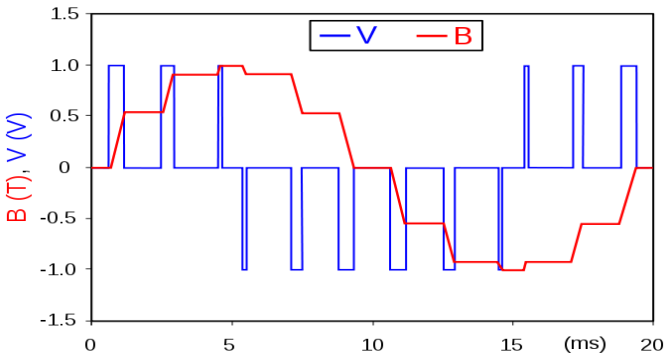


The design draws inspiration from the human leg which is very effective in climbing a wide variety of step sizes. The robot has an equivalent of a femur tibia and the ankle. The femur to tibia ratio is kept at 14:11.

The robot is made using weightless hardwood which has relatively high strength. The motion of the robot is controlled by PWM (Pulse Width Modulation) signals which is generated by the Arduino. The robot is powered by an 11.1V, 1000 mAh (3*3.7V, 1000mAh cell) battery. Pulse-width modulation (PWM), or pulse-duration modulation (PDM), is a modulation technique that conforms the width of the pulse, formally the pulse duration, based on modulator signal information. Although this modulation technique can be used to encode information for transmission, its main use is to allow the control of the power supplied to the various electrical devices.

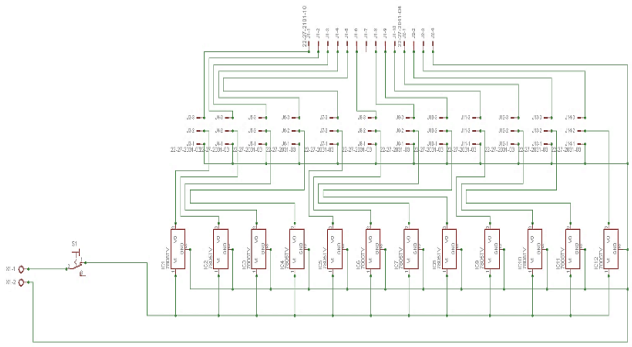
The Arduino code is fed in to the Arduino Mega ADK 2560 to generate PWM signals that turns the servo to a specific angle that enables it to climb the stairs. The power is distributed from the battery to the servo using a control board that is fabricated using the Toner Transfer Method. This method is very efficient and cost effective.





3.1 DESIGN OF POWER DISTRIBUTION BOARD

The power distribution board is just an accessory to the Arduino where it is used to safely deliver the power and PWM signal without any noise to the servo motor. The board is etched by the process called toner transfer method. The board is designed using Cadsoft Eagle software and auto routed.



Since each motor needs 500 mA at stall, it is calculated as 6*500mA=3000mA, which is under the maximum output current limit of IC 7805.

3.2 PART SPECIFICATIONS

PART	Specification	Qty.
Servo motors	FUTABA S3003	6
Arduino	MEGA ADK 2560	1
Power distribution board	Home fabricated as needed	1
Battery	11.1 V, 1000 mAh Li-Ion	1
Servo Extension Cables		As needed
Charger	Li-Ion Battery Charger	1

The servo motor is chosen such that the torque is enough to carry the robot's weight. The battery used here is a Lithium Ion battery which is very light. The Arduino used here can also be replaced with Arduino of some other versions or even Raspberry Pi. These are the important components in the robot. Few chemicals like Ferric Chloride, Tin chloride and thinner are required for etching the PCB in toner transfer method. A Laser printer is need to print the mirrored circuit diagram on to a photo paper where its later ironed on with a copper clad board to create PCB.

IV. ARDUINO PROGRAMMING

The Arduino is burned with these programs to instruct the board to generate the PWM signals and the pin corresponding to the PWM signals. For further development this board is interfaced with an android device in USB host mode of the Arduino mega ADK 2560. The ground in the Arduino is shorted with the ground in the power distribution board to avoid noise that is introduced.

V. CONCLUSION AND FUTURE SCOPE

In this paper we have developed an adjustable stair climbing robot to replace human effort to carry out mundane tasks in places like offices, hospitals, industrial and military automation, security systems and hazardous environments.

There is a lot of scope for improvement and this mechanism can be further modified and used in various other applications such as carrying heavy loads and thus further reducing human effort. Another scenariowhere this mechanism can be employed is during disaster management. A camera can be fitted on the robot to have a wide field of view of the affected areas which can further help in search and rescue operations.

This robot can further be integrated with mobile devices to process the images fed by the camera and act accordingly to the stairs.

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