STAIR CLIMBING ROBOT USING ARDUINO

Nandini G R[1], Jayadevappa R S[2], K Renuka [3], Madhurya B R[4], Shruthi M K[5], Basantha Kumari[6], Beena Sheril[7]

[1] *Assistant professor, E&CE Department, SJMIT, Karnataka, India*
[2] *Assistant professor, E&CE Department, SJMIT, Karnataka, India*
[3]*HOD, E&CE Department Govt polytechnic, Karnataka, India*
[4] *Senior Scale Lecturer E&CE, Govt polytechnic, Karnataka, India*
[5] *Associate professor, CS&E, Department, SJMIT, Karnataka, India*
[6]*Associate professor, CS&E, Department, SJMIT, Karnataka, India*
[7] *Assistant professor, CS&E, Department, SJMIT, Karnataka, India*

ABSTRACT

In this paper a tracked stair climbing robot will be developed. The robot can be controlled using any smart cell phone through Bluetooth and using switches. When designing the robot, the main constraints taken into consideration are the ability to climb the stairs in addition to the optimal size and weight; the robot needs to be small and light enough to get into places inaccessible by human. It needs also to be large enough to climb obstacles commonly found in any areas, such as rough terrains and stairs. Finally, it will be equipped with digital humidity and temperature sensor (DHT). A prototype of the stair climbing robot is designed and implemented, this robot is capable of moving on rough terrains and climbing a stair, it is portable due to the light material used in manufacturing. This robot will be controlled using two modes; the first one will use Arduino communicating by Bluetooth Module that can be connected with any smart mobile phone. The second mode (autonomous) will use the feedback from an gyro sensor installed at the top of the robot and is able to rotate using a servo motor. The prototype is tested on different rough and inclined terrains, on grassy ground and on stairs. The overall system works successfully and it performs very well. Video of the working prototype is provided.

Keyword: - *Arduino, DHT, Gyro sensor, and H-Bridge*

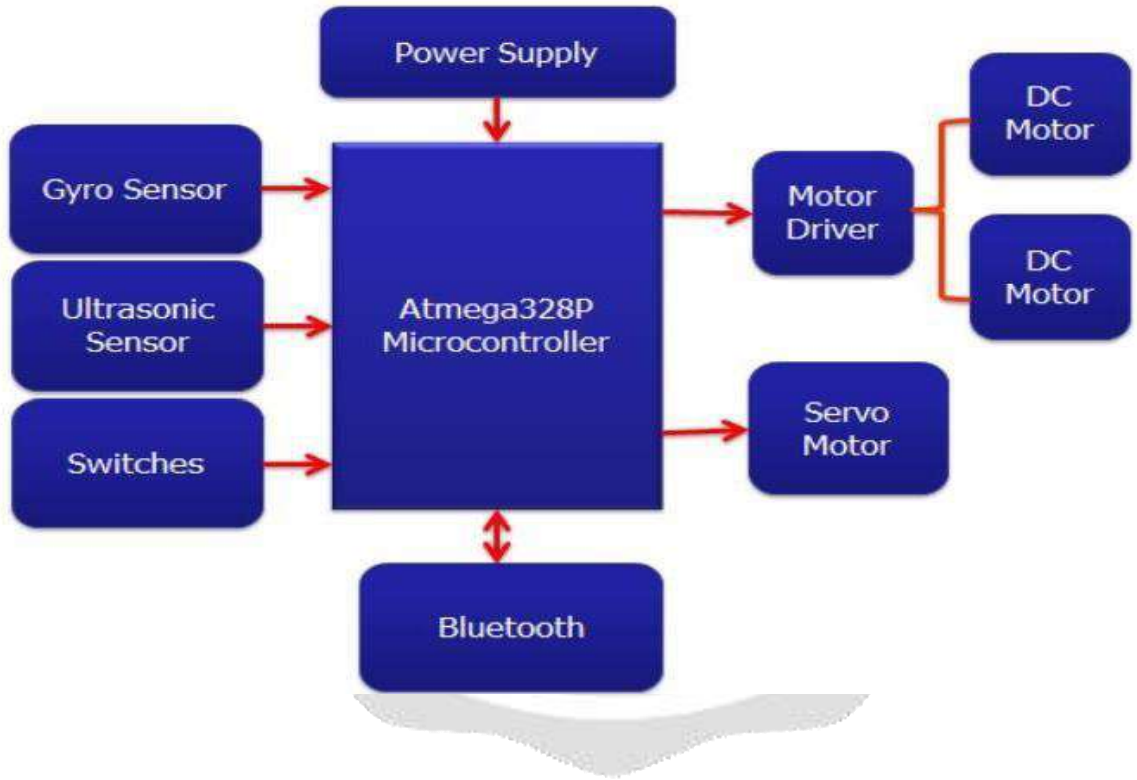
1. INTRODUCTION

Recently, design and implementation of a mobile robot has been of great interest for many researchers. Stair climbing robot is one of the most attractive and complicated applications of mobile robot. Stair climbing robot requires the ability to move on rough terrain. It has variety of important applications, such as moving on hazardous areas in order to perform different applications, such as military applications, checking the urban areas by carrying some materials on a platform and for rescue operations. Such applications required in many cases remote control of the mobile robot, and consequently keeping human away from danger. Many researchers have developed different designs of stair climbing robot using different types of mechanisms including wheeled, legged, and tracked robots. The advantages of a tracked robot include the large contact surface with the ground and consequently more stable design due to the fact that it has low center of gravity. Examples from the literature includes home caring robot to provide service for the elders. The Authors developed a robot that contains main body that is equipped with two brushless DC motors and a front and rear arms. The Author in developed a rescue robot that is capable to go into slightly destroyed areas to find and help rescue people, he used PIC16F877 for controlling the movement of the robot in four directions, namely; left/right, and forward/backward, they also installed a camera. In a Fuzzy logic controller was applied for an autonomous stair climbing robot in order to keep the robot away from stairway sides to

guarantee a safe stair. The Authors in developed a stair climbing robot without assuming prior knowledge of the stair geometry.

In a stair climbing robot with autonomous movement is developed, a dual tone multi frequency technique is used to operate and control the movement of the robot. A stair climbing robot to climb multiple flights of stairs is developed by the Authors in, they developed a software architecture to demonstrate the ability of a tank-like robot to climb a stair. The algorithm is to incorporate intelligent sensor fusion and hierarchical modular structure. A surveillance robot with staircase climbing capability for home security is developed by the Authors in, the robot can climb up stairs of certain dimensions, and it is equipped with camera and other sensors for surveillance purposes. In a portable robot with dexterous manipulator and wearable controller for dismounted mobile operations is developed. The robot can maneuver in inaccessible areas to provide help. In this paper a stair climbing robot will be developed, it is equipped with a digital humidity sensor to measure the environmental conditions. In addition, it is controlled using either Bluetooth connection using any smart cell phone, or using the autonomous mode depending on the feedback signal from an ultrasonic sensor and gyro sensor.

2. BLOCK DIAGRAM



In general, a mobile robot mainly consist of five main parts: 1.sensors to provide a feedback signal about the environmental and/or surrounding conditions, 2.controller to provide the appropriate signal to the actuators, 3. actuators to provide the needed motion, 4.driver to protect the micro controller from excess current and 5. Communication system to transmit and receive the data. In this paper a stair climbing robot is designed such that it has the following specific parts corresponding to the aforementioned main parts: 1. Ultrasonic sensor, gyro sensor and digital humidity and temperature sensor (DHT), 2.Arduino as a controller, 3.DC-motors and servo motors, 4.H-bridge driver, 5.Bluetooth module for Arduino. Following subsections provide a brief description of the three main parts of the system, namely; the robot mechanism, the motor drive circuit and the control modes.

3. METHODOLOGY

Robot mechanism the stair-climbing robot consists of a main body, and a front arm that helps moving up stairs. The main body is equipped with four DC motor, gears for torque amplification, two servo motors; one to control the two arms and the other to control the ultrasonic, gyro sensor and an Arduino with interfacing circuit for controlling the process. B- Motor drive circuit In the interfacing circuit between the motor and the Arduino an H-bridge driver is used to control the speed and the direction for the DC motors. The DC-motors sourced by 12 V in parallel and connected to the H-bridge driver, the servo motors sourced by 6 V in parallel and connected to the Arduino. The Arduino sourced by 9 V and there is Bluetooth module and DHT sensor connected directly to the Arduino. C- Control modes In this paper the operation of the robot is implemented by two modes, the first mode is fully controlled by a smart cell phone using an application downloaded on the cell phone to send the information to the Arduino by a Bluetooth module. The main advantage of this mode is the ease of speed control, and the ability to provide measurements of temperature and humidity, which is displayed on the smart cell phone by send and receive program. The second mode is autonomous mode in which the operation depends on the feedback from the gyro sensor. The robot equipped with the gyro sensor, the small servo motor on autonomous mode. The main idea of the autonomous mode is to measure an orientation (angle) of the robot using a gyro sensor that can control the robot movement by using the servo motor. If there is no changes angle, it means that there is no stair, and then the robot can go forward. If the difference on the angle exceeds 0.3 degree, it means that the robot start to climb the stair, then the controller will position the arm at 0 degree to pull up the robot. If the difference on the angle is less than 0.3 degree then the controller will position the arm at 45 degree, which means that the robot finished climbing. And so on..

3.1 WORKING OF STAIR CLIMBING ROBOT:

The customized wheelchair will take directional instructions as input from driver and will drive the wheels accordingly as per processed logic. In the event of staircase climbing, the driver has to orient the wheelchair with backside facing the stairs. Then continue normal traversing until the first step is covered. In order to maintain stability, the servo motors will then align the sitting platform horizontal to ground by rotating through an angle. While undertaking this process, 3 axis Accelerometer will continuously monitor the level change of platform with respect to gravity and will help in achieving accuracy and stability With this configuration, one can climb the further steps with ease. When the distance to potential colliding object measured by ultrasonic sensors violate the threshold preset conditions, an alert will be provided by buzzer to stop the wheelchair automatically operation and will wait for next user's instruction to switch to continue moving , keeping minimum distance to detected object in mind.
Electronically, we have interfaced multiple sensors such as ultrasonic sensor, Bluetooth hc-05 model, push button switches, gyro sensor etc, like wise output devices we have interfaced dc motors are interfaced with motor driver, servo motor, buzzer. Here we can control wheelchair with three interfaces such as switches, Bluetooth, voice recognize. And also ultrasonic sensor used for obstacle.
We are using 4 push button switches for the moment of the robot like forward, backward, left and right.

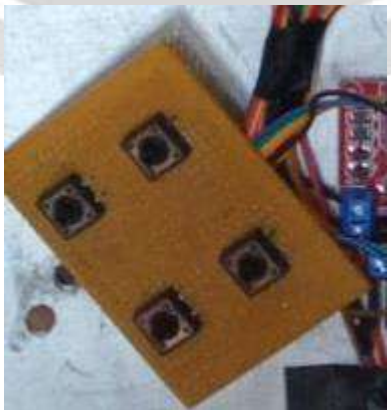


Fig 3.1(a): switch interfacing

When switch 1 is pressed it starts moving forward, like when switch 2 is pressed it starts moving backward, switch 3 is command for to move left and switch 4 is command for to move right. These four push button switch are used for control the moment of robot by manually.

We are also using Bluetooth model for control the wheelchair through mobile app same as that working of push button switches.

Fig 3.1(b): Bluetooth app controller interface

The fig 3.1(b) shows the Bluetooth app controller on mobile. when upper side button is pressed it moves forward, like when down side button is pressed it moves backward like left and right buttons are command for to move left and right. To connect Bluetooth we need pair the mobile app with Bluetooth module, first turn on the Bluetooth on mobile and search the name shows like voice controlled robot and click on it and pair the mobile app with Bluetooth module. After successfully paired with mobile app search the name shows on the mobile app like stair case Click on it and connect the Bluetooth module with app.

3.2 MECHANISM OF STAIR CLIMBING:

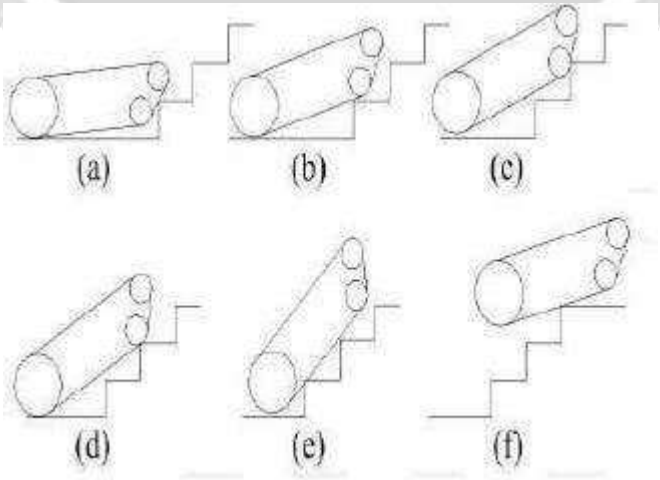


Fig 3.2(a): stair climbing mechanism

During stairs-climbing, the wheelchair begins by touching the first step of the stairs through its front track while its two-sided driving motors simultaneously push the driving wheels and the whole wheelchair forward, up to the first step and then the second step, whereby the entire robot leaves the ground and completely climbs upwards on the stairs. The whole process may be divided into six stages, as shown in Figure 3.2(a) : a) touch the first step; b) climb up the first step; c) touch the second step; d) climb up the second step; e) leave the ground and then ascend the stairs; (f) leave the stairs and then access the ground. Here, touching the step means the track near the robot's front approach angle climbing onto the step, while climbing up the step means the bottom track of the robot climbing onto the step.

4. CONCLUSION

Given a wheelchair the issue of how to ensure stability in stairs-climbing is an important problem which needed to be solved. Looking at this problem, the dynamical model and the question of stability during wheelchair's stairs climbing are studied based on a mechanics analysis. The acquired achievements can provide design and analysis foundations for the wheelchair' stairs climbing and solve the problem, which can be summarized as follows:

(1) According to the requirement for stairs-climbing, the mechanical structure of a tracked mobile robot is designed and the hardware composition of its control system is given.

(2) Based on the analysis of the stairs climbing process, the dynamics model of the tracked mobile robot during stairs-climbing is established, which can provide fundamental support for the stability analysis.

5. REFERENCES

[1]. Ming-Shyan, Wang and Yi-Ming Tu , "Design and Implementation of a Stair- Climbing Robot", IEEE International Conference on Advanced Robotics and its Social Impacts Taipei, Taiwan, Aug. 23-25, 2008

[2]. Basil Hamed, "Design and Implementation of StairClimbing Robot for Rescue Applications", International Journal of Computer and Electrical Engineering, Vol. 3, No. 3, June 2011

[3]. E. Mihankhah†, A. Kalantari†, E. Aboosaeedan†, H.D. Taghirad‡, and S.Ali.A. Moosavian§, "Autonomous Staircase Detection and Stair Climbing for a Tracked Mobile Robot using Fuzzy Controller" , Proceedings of the 2008 IEEE International Conference on Robotics and Biomimetics Bangkok, Thailand, February 21 - 26, 2009

[4]. Anastasios I. Mourikis, Nikolas Trawny, Stergios I. Roumeliotis, Daniel M. Helmick and Larry Matthies, "Autonomous Stair Climbing for Tracked Vehicles" , The International Journal of Robotics Research 2007 26: 737, DOI: 10.1177/0278364907080423

[5]. T.Sairam Vamsi and K.Radha, "ARM Based Stair Climbing Robot Controlling Through DTMF Technology", International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-2, Issue-3, July 2013

[6]. Solomon Steplight, Geo_rey Egnal, Sang-Hack Jung, Daniel B. Walker, Camillo J. Taylor and James P. Ostrowski, "A Mode-Based Sensor Fusion Approach to Robotic StairClimbing", proceedings of the 2000 IEEE/RSJ international conference on intelligent robot and systems

[7]. Dipali Chavan and S.A. Annadate , "A Surveillance Robot with Climbing Capabilities for Home Security", International Journal of Computer Science and Mobile Computing IJCSMC,
Vol. 2, Issue. 11, November 2013, pg.291 – 29