Intelligent Autonomous four-legged walking robot to operate on uneven surfaces

K.KARIMULLA, M.Tech(AMS),Bheema Institute of Technology and Science, Adoni.
RAYAPURI ASHOK, Professor and HOD, Department of Mechanical Engineering, Bheema Institute of Technology and Science, Adoni. AP.

Abstract

This paper presents design and development of an intelligent robot that easily operates on uneven surfaces with four-legged arms. Legged robots are appropriate to stroll on troublesome landscapes to the detriment of requiring complex control frameworks to walk even on level surfaces. Be that as it may, essentially strolling on a level surface does not merit utilizing a legged robot. It ought to be expected that strolling on an unexpected landscape is the run of the mill circumstance for a legged robot. In view of this commence, we have used anArduinomicrocontrollerwith obstacle sensor, servo motor for a four-legged robot that enables it to stroll over troublesome landscapes in a self-sufficient route using 2 bar link mechanism.

Keywords: Arduino microcontroller, 8 Servo motors, obstacle sensor.2- bar linkage mechanism

1. Introduction.

Over the counter the research based on legged motility robots has developedgradually. Legged robots have an unarguable benefits concluded above the wheeled robots intern of mobilization, energy consumption. Legged robots travel on uneven ground and or to cross waterways or steps where wheeled robots could be useless. The legged robots move in uneven landscapes by changing their leg alignment, in order to familiarize themselves to the surface irregularities. The feet may begin interaction with the land in the selected points in accord with the landscape situations. In spite of the fact that legged robots have potential advantages, in the current state of development, there are numerousfeatures that need to be upgraded and enhanced. This is an intelligent robot system that can easily move on uneven surfaces with the help of four legs and can proceed by its own decision in case of any obstacle approaches. This robot is quite an intelligent system,whenever an obstacle is detected; the robot changes its direction and moves in other direction. It is assumed that walking on difficult terrain is the typical situation for a legged robot.It is critically important for a walking robot to travel along a desired path accurately, while in Service in hazardous workplaces viz. de-mining operations, nuclear power plants, space missions etc. To avoid cost and risk involved in sending human beings into these environments and improving the probability of mission success, robots must be able to quickly detect and tolerate Internal and/or external failures without relying on human intervention.

The proposed system is a vigorous regulator for a four-legged robot that allows it to walk over difficult landscapes in a self-directed way; with a limited use of sensory information. By the proposed system, described in this paper, the low-cost, simple and friendly four legged walking robot.

2. LITERATURE SURVEY

Less study was done related with odd legged robot movement compare to even legged robotdue to several factors. Even legged robot movement is easier to develop by observing the movementof insects while there are no sample can be used for odd legged robots development. Insect movementcan be used as a model for legged robots since insect movement can be concluded will produce very stable gait. Insect movement cannot be equated with odd legged robot because there are no insectwhich move stable with odd legs [1]. Related studies about hexapod robot gait had been discussed through biological observation. Reference [2] explains that the hexapod robot still can move eventhough one leg does not function because the balance of the robot can still be maintained due to staticstability. However, to maximize the static stability, the study for five legs gait is required. Theyintroduce method for five-legged robot to consider a case when one of the hexapod robot leg malfunctions. To maintain stability during movement, hexapod robot configuration change into thepentagonal shape is proposed in the study.Nowadays, studies had been carried out for five-legged robot are not only based on thehexapod robot with one leg malfunction but also from nature based such as idea from starfish [3].Reference [4] focused Brittle Star to develop flexible myriapod robot. They

develop a five leggedrobot that can move forward. In addition, the synchronized motion is also very important for multi-legrobots. This study proposes synchronous movement method that utilized the idea of autonomousdistributed systems. There are also other studies that discuss the methods used to develop a multi-legrobot such as Reinforcement Learning of Walking Behavior [5] for a four legged robot andDistributed Reinforcement Learning [6] for a hexapod robot to walk. Most of the proposed methodsuse the degree of freedom tuning as the main parameter for robot to move.A lot of motors are required to enable the robot to move likehumans causing the robot's weight increases, higher costs and more complex control circuit. Biggestchallenge in developing two – legged robot is to enable it to move like human walking. Since 1980, several studies have been initiated with a focus on bipedal robot. Reference [7] focuses onthepassive dynamic walking to enable a biped robot on level ground to walk efficiently with simplemechanism. They propose the level-ground walking by controls the robot torso during the legswinging process. Leg swinging is controlled depending on the current robot stance. This study alsoanalyses the stability of the biped robot to demonstrate the effectiveness of the proposed method. Astudy from [8] addresses the problem of energy-optimal gait generation for biped robots. They studya complete gait cycle comprising single support, double support and the transition phase. The energyoptimal gaits for each phases is compared to normal human gait. A study about feedback controller for asymptotically stability was done by [9]. Several strategies had been explored to achieve the stabilitywhich are imposing a stability condition during the search of a periodic gait by optimization, uses anevent-based controller to modify the eigenvalues of the (linearized) Poincare map and the effect of output selection on the zero dynamics. There are paper about optimization of dynamic gait for small bipedal robots [10] which discusses the parameters that effect dynamic gait and how these effects will be implemented in a servo skeleton robot.Most of this studies use more than six servomotors to develop walking robot. Actual study is now taking place on the biped robot with smaller number of servomotors to achieve the statedobjectives.

3. Proposed system:

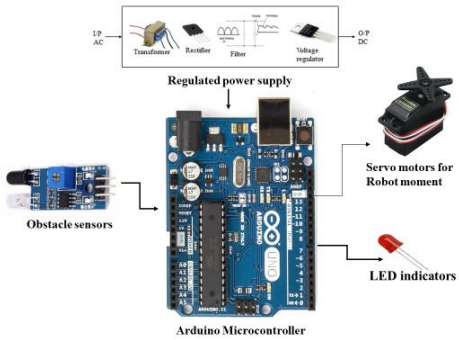

Figure 1:Block diagram of Intelligent Autonomous four legged walking robot to operate on uneven surfaces

The Figure shows the main block diagram of the proposed model where to Arduino microcontroller all components are connected.

Working:

The project aims at designing an intelligent four (Quadruped) leg walking robot. The Robot is autonomous which takes decisions on its movements by itself by using obstacle sensors and moment using servo motor.2 bar link mechanism is used to Robot legs moments.

The main controlling device of the whole system is a microcontroller. Obstacle sensors, Servo motors are interfaced to Microcontroller. The detection obstacle by the sensors is fed to microcontroller. The microcontroller acts accordingly on the servo motors as written in the program embedded into it and 2 bar link mechanism is used to Robot legs moments. The microcontroller is loaded with an intelligent program written in Arduino IDE language.

Arduino Microcontroller:

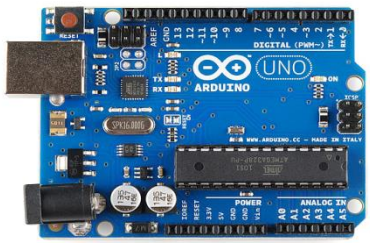

Figure 2:Arduino board

Arduino is an open source, computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building

digital devices and interactive objects that can sense and control objects in the physical world. AArduino boards are available commercially in preassembled form, or as do-it-yourself kits.

Arduino microcontrollers are pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory. The default boot loader of the Arduino UNO is the Opt boot loader. Boards are loaded with program code via a serial connection to another computer.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (*shields*) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

Servo motor:

Figure 3: Servo motor

Here servo motors are used to move the Robot. Servomotors are designed to operate control surfaces on hobby RC planes. So they do not rotate continuously. Rather they are designed to rotate through 180 degrees with precise position control. If you want to use them as the main drive motor for a mobile robot you need to modify them so that they will rotate continuously. This is not a difficult thing to do. I will not cover it here but if you want to do it there are many sites on the web that cover this.

They do not simply run on a DC voltage like a standard DC motor. They have 3 wires. Red is power (generally 3V – 12V max), black is ground and then there is another wire, usually white or yellow that is the "input signal wire".

In this project total 8 servo motors are used for moment of Robot

Obstacle sensor:

Figure 4: Obstacle sensor

This sensor is a short range obstacle detector with no dead zone. It has a reasonably narrow detection area which can be increased using the dual version. Range can also be increased by increasing the power to the IR LEDs or adding more IR LEDs

The photo above shows my test setup with some IR LED's (dark blue) as a light source and two phototransistors in parallel for the receiver. You could use one of each but I wanted to spread them out to cover a wider area. This setup works like a FritsLDR but with IR. It has a range of about 10-15cm (4-6 inches) with my hand as the object being detected.

Mechanism data:

Linkage Mechanisms:

Have you ever wondered what kind of mechanism causes the wind shield wiper on the front widow of car to oscillate. Let's make a simple mechanism with similar behavior. Take some cardboard and make four strips, Take 4 pins and assemble them. Now, hold the 6in. strip so it can't move and turn the 3in. strip. You will see that the 4in. strip oscillate

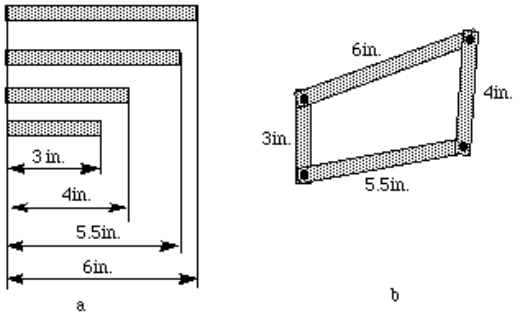

Figure 5: Simple example of linkage

The Lever is a 2-bar Linkage

A lever (link) can be used with a fulcrum (pivot) against the ground (link) to allow a small force moving over a large distance to create a large force moving over a short distance. When one considers the means to input power, a lever technically becomes a 4-bar linkage. The forces are applied through pivots, and thus they may not be perpendicular to the lever –Torques about the fulcrum are thus the best way to determine equilibrium, and torques are best calculated with vector cross product –Many 2.007 machines have used levers as flippers to assist other machines onto their backs.

Degrees of freedom:

In mechanics, the degree of freedom (DOF) of a mechanical system is the number of independent parameters that define its configuration. It is the number of parameters that determine the state of a physical system and is important to the analysis of systems of bodies in mechanical engineering, aeronautical engineering, robotics, and structural engineering.

The position of a single car (engine) moving along a track has one degree of freedom, because the position of the car is defined by the distance along the track. A train of rigid cars connected by hinges to an engine still has only one degree of freedom because the positions of the cars behind the engine are constrained by the shape of the track.

5. CONCLUSION

The existing model presents an Integrating feature of all the hardware components. The presence of each and every module has been reasoned out and placed very carefully. Hence the contributing to the best working unit for "**Intelligent Autonomous four legged walking robot to operate on uneven surfaces**" has been designed perfectly. Thus, the project has been successfully designed and tested.

6. ACKNOWLEDGEMENT

We would like to thank all the authors of different research papers referred during writing this paper. It was very knowledge gaining and helpful for the further research to be done in future.

REFERENCES

[1] Inagaki K.: Gait Study for Hexapod Walking with Disable leg. In: Proceedings of the 1997

IEEE/RSJ International Conference on Intelligent Robot and Systems (IROS 1997), Vol. 1,

pp. 408-413 (1997)

[2] Inagaki K., Kobayashi H.: Adaptive Wave Gait for Hexapod Syncnronized Walking. In:Proceedings IEEE International Conference on Robotics and Automation, Vol. 2, pp. 1326-

1331 (1994)

[3] A.R.A. Besari, R. Zamri, A.S. Prabuwono, S. Kuswadi: The Study on Optimal Gait for Five-Legged Robot with Reinforcement Learning. In: Intelligent Robotics and ApplicationsLecture Notes in Computer Sciences, Vol. 5928, pp. 1170-1175 (2009)

[4] Maikoto T., Koji Y., Satoshi E.: Studies on Forward Motion of Five Legs Robot (NipponKikaiGakkaiRobotikusu, MekatoronikusuKoenkaiKoenRonbunshu). Journal Code:L0318B 2005, 2P1-S-065 (2005)

[5] Kimura H., Yamashita T., Kobayashi S.: Reinforcement Learning of Walking Behavior for aFour-Leg Robot. In: Proceedings of the 40th IEEE Conference on Decision and Control (2001)

[6] Zennir Y., Couturier P., Betemps M.: Distributed Reinforcement Learning of Six-LeggedRobot to Walk. In: The Fourth International Conference on Control and Automation (2003)

[7] TerumasaNarukawa, Masaki Takahashi, Kazuo Yoshida: Stability Analysis of a SimpleActive Biped Robot with a Torso on Level Ground Based on Passive Walking Mechanisms(Humanoid Robots: Human-Like Machine edited, Book by: Matthias Hackel). Journal Code:978-3-902613-07-3, pp. 642 (2007)

[8] L. Roussel, C. Canudes-de-Wit, A. Goswami: Generation of Energy Optimal Complete Gait

Cycles for Biped Robots (Laboratoired'Automatique de Grenoble, INRIA Rhone-Alpes)

[9] Christine Chevallereau, J.W. Grizzle, Ching-Long Shih: Asymptotically Stable Walking of a

Five-Link Underactuated 3D Bipedal Robot. In: Regular Paper Submitted to IEEE TRO

(2008)

[10]Peter Gibbons, Martin Mason, Alexandre Vicente, Guido Bugmann, Phil Culverhouse:Optimisation of Dynamic Gait for Small Bipedal Robots. In: Proceedings of the 4thWorkshopon Humanoid Robots (Humanoids 2009), pp. 9-14 (2009)