*IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)*
*e-ISSN: 2278-2834,p- ISSN: 2278-8735.Volume 11, Issue 3, Ver. III (May-Jun .2016), PP 46-50*
*www.iosrjournals.org*

# Arduino Quadruped Robot

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***Abstract:*** *Less than half the Earth's landmass is accessible to existing wheeled and tracked vehicles. But people and animals using their legs can go almost anywhere. Our mission is to develop a new breed of rough-terrain robots that capture the mobility, autonomy and speed of living creatures. Such robots will travel in outdoor terrain that is too steep, rutted, rocky, wet, muddy, and snowy for conventional vehicles. They will travel in cities and in our homes, doing chores and providing care, where steps, stairways and household clutter limit the utility of wheeled vehicles. Robots meeting these goals will have terrain sensors, sophisticated computing and power systems, advanced actuators and dynamic controls. Legged robots offer the potential to navigate highly challenging terrain, and there has recently been much progressing this area. However, a great deal of this recent work has operated under the assumption that either the robot has complete knowledge of its environment or that its environment is suitably regular so as to be navigated with only minimal perception, an unrealistic assumption in many real-world domains. In this paper we present an integrated perception and control system for a quadruped robot that allows it to perceive and traverse previously unseen, rugged terrain that includes large, irregular obstacles.*
***Keywords:*** *rough-terrain robots, conventional vehicles, advanced actuators and dynamic controls.*

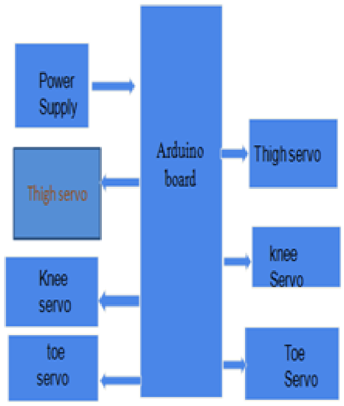
## I. Introduction

Robotics is the branch of engineering science & Technology related to robots, and their design, manufacture, application, and structural disposition. Robotics is related to electronics, mechanics, and software. Robotics research today is focused on developing systems that exhibit modularity, flexibility, redundancy, fault-tolerance, a general and extensible software environment and seamless connectivity to other machines, some researchers focus on completely automating a manufacturing process or a task, by providing sensor based intelligence to the robot arm, while others try to solidify the analytical foundations on which many of the basic concepts in robotics are built. In this highly developing society time and man power are critical constrains for completion of task in large scales. The automation is playing important role to save human efforts in most of the regular and frequently carried works.

One of the major and most commonly performed works is picking and placing of jobs from source to destination. Present day industry is increasingly turning towards computer-based automation mainly due to the need for increased productivity and delivery of end products with uniform quality. The inflexibility and generally high cost of hard-automation systems, which have been used for automated manufacturing tasks in the past, have led to a broad based interest in the use of robots capable of performing a variety of manufacturing functions in a flexible environment and at lower costs. The use of Industrial Robots characterizes some of contemporary trends in automation of the manufacturing process. However, present day industrial robots also exhibit a monolithic mechanical structure and closed-system software architecture. They are concentrated on simple repetitive tasks, which tend not to require high precision. The pick and place robot is a microcontroller based mechatronic system that detects the object, picks that object from source location and places at desired location. For detection of object, infrared sensors are used which detect presence of object as the transmitter to receiver path for infrared sensor is interrupted by placed object.

## II. Block Diagram

A switch is provided to control the robot, when we switch on the robot power is supplied to the controller and to the servos simultaneously. Servos are given power through servo drivers. According to program written in the controller servos will be moving in a certain direction, as we followed walking algorithm that too for forward condition we will see that robot will be moving forward. To stop the robot when obstacle is detected we use ultrasonic sensor which will be telling the controller where the object is. We need to extend this project for more applications and autonomy.




First the power supply is connected to the robot controller which enables it to operate and control the rest of the components connected to it. Ultrasonic sensor which is connected to it measures the distance between bot and the objects and it also instructs the bot to avoid obstacles and also helps in picking the objects by controlling the servos with the given data.

## III. Software Requirements

**Arduino IDE:**

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This is where you type the code you want to compile and send to the arduino board. The Intial Setup: We need to setup thee environment to the Tools menu and select Board Then select the type of Arduino you want to program,in our case it's Arduino The code you write for your Arduino are known as sketches. They are written in c++.

## IV. Working

### 4.1 Mechanical Design

The way this robot is assembled together only works because it's so lightweight. Would the robot be heavier, there would be significant problems:Servomotors are used as structural elements.The printed circuit board is also used as a structural element.The whole robot weight rests sideways on the servo shafts.The servo horns used for legs are elastic.The screws that come with the servos are too big for what they used for.The servo cables are all over the place.The power switch is in an awkward place.There is no good way to attach the battery.The legs need some rubber at their ends, or they will slip.Most of those problems can be solved by using better materials and adding some structural support elements, but that affects the price and complexity.

### 4.2 Electrical Design

The desire to cut costs and minimise the number of parts also made me make some not-entirely-kosher decisions on the electrical side of things:The servomechanisms are correctly powered. The specification asks for 6V, and they get 6V from servo driver which draws power from LiPo battery.The servomechanisms are powered from the servo motor drivers.The undercharge battery protection is software-based, which means it can easily fail.There is no battery charger build in. You have to disconnect the battery to charge it.The Arduino mega board is soldered directly onto the perf board.

### 4.3 Walking Algorithms

The way in which an animal or a robot walk is called a gait – it tells us how and in what order the legs are moved, how the body is balanced and how it moves forward.

**Statically and Dynamically Stable Gaits**

When the robot walks, it has to keep its balance. There are two general strategies for doing that, and according to them, we divide the gaits into statically stable and dynamically stable.

For statically stable gaits it doesn't matter how fast they are performed, or whether the robot is stopped in a middle of a step – it is stable at any moment, at all times. Animals and people use those gaits when they want to go slowly, or when they want to be able to stop at any time. An example of such a gait is the "creep" gait, used by cats stalking their prey.

Dynamically stable gaits are much harder, as they have to be performed at a particular speed and cannot be interrupted at an arbitrary point. They are sometimes called "controlled falling", as they exploit the fact that it takes some time for the robot to fall when it's unstable, and that time can be used to move the legs in such a way as to prevent the fall. Most animal gaits are dynamically stable, as they tend to be faster and more energy-efficient. An example of a simple dynamically stable gait is the "trot" gait.

**Raising a Leg**

When the robot raises one of the legs, its area of support changes dramatically, that our center of mass is directly on an edge of our area of support. That's bad, because the smallest force can now tip our robot and make it fall. We can avoid that by moving all the legs toward the one leg that we want to raise before raising it, so that the center of mass shiftsThere are also other methods of balancing, not covered here. For example, many animals have a flexible spine, that they can bend sideways to shift their center of mass. Other animals have tails that they use to balance. Possibilities are endless.

**Moving Forward**

The simplest solution to do that, at least initially, is to just move all the legs that are touching the ground backwards. If we do it slow enough, so that they don't slip, they will stay where they were, but move the body of the robot forward. This is an excellent way of moving around, and many industrial robots do it this way, bolted to the floor in one place. There is however a small problem: the range is quite limited. Sooner or later you will either move your center of mass outside the support area, or your legs move to their maximum range. What then?

Then you raise the legs from the ground, move them forward, and set them down in the new place. But you have to be smart about it, because if you do it with all the legs at once, you will fall down. But you can raise a single leg and still stand on the remaining three. You can also raise and move that leg*while* moving the remaining legs backwards, which saves you some time and makes it both faster and more smooth.

Now, as you know, if you are raising a leg, you also have to make sure that the center of mass stays inside the support area. To do that, you will have to shift the robot's body away from the leg that you are rising. Since you are shifting your body forwards, it is also important in which order you raise the legs – some orders will be more stable than others.

## V. Comparison between Previous and Present Models

Quadruped robots have a large number of real life applications, from crossing potentially dangerous terrain to carrying out search and rescue operations in hazardous and unpredictable disaster zones (Karalarli, 2003). They have a number of advantages over wheeled, quadruped or bipedal robots:

- While wheeled robots are faster on level ground than legged robots, quadruped are the fastest of the legged robots, as they have the optimum number of legs for walking speed - studies have shown that a larger number of legs does not increase walking speed.
- Quadruped are also superior to wheeled robots because wheeled robots need a continuous, even and most often a pre-constructed path. Quadruped robots however can traverse uneven ground, step over obstacles and choose footholds to maximise stability and traction.
- Having maneuverable legs allows Quadruped robots to turn around on the spot .
- In comparison to other multi-legged robots, quadruped robots have a higher degree of stability as there are can be up to 5 legs in contact with the ground during walking. Also, the robots center of mass stays consistently within the tripod created by the leg movements, which also gives great stability (Mushrush & Spirito, 1978).
- Quadruped also shows robustness, because leg faults or loss can be managed by changing the walking mechanism (Ding et al, 2010).
- This redundancy of legs also makes it possible to use one or more legs as hands to perform dexterous tasks.

Because of all of these benefits, quadruped robots are becoming more and more common, and it will be interesting to see what modifications roboticists come up with to further improve and develop their form and function.

**5.1 Advantages**

Legged robots or vehicles can navigate on any kind of surfaces which is inaccessible for robots with wheels. In the previous section, we discussed different kinds of wheels for different surfaces, but no standard works on all surfaces. Also, wheels are designed to work on prepared surfaces like smooth surfaces, roads, rails, etc.

- Legged robots can jump or step over obstacles whereas wheels need to somehow travel over it, or take a different path

- Wheels require a continuous path to travel whereas legs can step over isolated paths and move on. For example, if a particular city is hit by an earthquake, then the surface with a continuous path. This is where legged robots come into picture, although tracked wheels can manage up to a “certain” extent.
- Legged robots can avoid undesirable footholds which cannot be avoided in a wheeled robot
- Legged robot helps us in exploring human and animal locomotion
- Once we move off from our modified habitat into rough, rocky, sandy, steep and undesired terrain, we understand that our brilliant invention of wheels turn out absolutely useless
- Lastly, the excitement of replicating a human or an animal and try to challenge nature

Walking with four legs is common for most animals and there is a good reason to replicate this in robots. Four legged robots are statically stable and the walking pattern of a four legged robot can be designed in different ways:

- One leg at a time: At any point there are three contact points to surface and the robot maintains static stability while standing or moving. Moving one leg at a time makes your robot slower and expensive on the resources, but keeps it stable.
- Alternating Pair: In this approach, alternate legs are moved as if two biped robots are connected together. At any time the robot has two surface contact points creating a dynamically stable robot. Faster and efficient, but less stable compared to the first approach.

## VI. Conclusion

Today we find most robots working for people in industries, factories, ware houses and laboratories. Robots are useful in many ways. For instance, boosts economy because businesses need to be humans can, e.g.robot can build, assemble a car. yet robots cannot perform every job, today robots roles include assisting research and industry .Finally ,as technology improves, there will be new ways to use robots which will bring new hopes and new potentials. The perceived disadvantages of robots are mostly physiological. The fear of loss of control to machines that rival or exceed our capabilities. The advantages are both physiological and practical it would be easier to interact with a machine that looks and acts as human. The main practical advantage is that a legged robot would be able to move and work in the human environment without need for its modification .

Given the present level of technology, the question is posed: Are we ready to move towards personal robotics, and what might be the first step? A possible answer to this question might be given through the analysis of human-like characteristics of a personal robot must posses: human-like motion, human-like intelligence, human-like communication. Such a challenging goal requires co-ordinated and integrated research efforts that span over wide range of disciplines such a system theory, control theory, artificial intelligence, material science, mechanics, and even bio mechanics and neuroscience. Thus the research is risky, but the target is challenging and promising.

Our opinion that result achieved in the domain of human-like motion or still rather limited, while in the domain of human-like communication several viable alternatives have been produced. However, Human like walking is the main obstacle to be overcome because of its complexity and multi dimensionality ;it is also responsible for co-ordination of the entire personal robot behaviour.

**Fig 6.1** Arduino Based Quadruped Robot

**Future Scope:**
**Modifying and Extending**

Since this robot is so simple, it is very easy to modify or extend it. You can add sensors and peripherals, or control it remotely from another computer or directly with another microcontroller or microcomputer board.

The possibilities are infinite, as long as the board in question has a serial or I²C interface, can be powered from a single LiPo battery, and doesn’t weight too much for the robot to carry it.

If your board or module can be powered with 3.3V, simply use the FTDI header of your Pro Mini for connecting it – it has broken out the power and serial interface. You will have to write the code for communicating with the board yourself.

If the board requires 5V or considerable amounts of current, you don't want to power it from Pro Mini's power regulator. Instead, add pins to the RAW and GND pads on it, and to the RX and TX pads.

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