DESIGN, ANALYSIS AND EXPERIMENTS OF AN All-TERRAIN-ROBOT (ATR)

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ABSTRACT

The aim of this work is to design a mobile robot which can adjust to its shape to environment. It should be able to operate on different types of surfaces. The prposed design is an All Terrain Robot (ATR) which operated using four wheeled legs (including coupled wheels sets). Two servo motors are installed per a leg in order to bend and one geared motor wheel to go forward and steer. Front sonar sensor is installed to measure distance and identify obstacles. It has transforming ability, therefore it is able to transform into various positions. The 3D figures were designed by using SOLID WORKS software, all the electronic circuits were tested by using PROTIUS simulator software and exterior body was designed by using LASER CUTTING machine.

***Key words*:**Terrain robot, Obstacle detection

1. INTRODUCTION

The history of robots has its origins in the ancient world. The modern concept began to be developed with the onset of the industrial revolution which allowed for the use of complex mechanics and the subsequent introduction of electricity.

What is a "ROBOT" and why do we use robots? A machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer and these monster machines used mainly to save labor and reduce cost. This is a robot that is designed to drive over just about any terrain for use with surveillance, academic research, and most practical robotic applications.

Even though All Terrain Robot is not a new type of a robot, our product has extra features. It exists with four transformable wheeled legs and it is including different mechanisms. 4 legs are connected to a base plate. It controls all the mechanisms by using internal power source and built in circuit.

Since it has power full servo motors and power full Li-Po battery (11,000mAh), it has enough performance to drive through several incline planes and stair cases. Even though robot needs constant stable voltage and high current when it's moving we are using Li-Po battery. All the overcoming obstacles will be analyzed by using rotatable (180 degree) front sonar detection sensor. People have designed all terrain robots with six or eight wheeled legs few years before but this robot will be able to achieve all the targets by using fourlegs. In order to travel on highly inclined planes the center of gravity will be reduced by transforming the robot. Then the stability will be increased.It can climb a slope of 60 degrees. Special wheels have used in order to maximize the friction between the floor and the robot.Apart from that it's having the ability to go through outdoor areas. It automatically transforms according to the surface.In nut shell this robot could travel over any environmental condition except water.

2. BACKGROUND

The developed design of the ATR has 4 robot legs. Each leg has two separate wheels which are controlled by a PWM gear motor. Total number of 4 PWM motors allow the ATR to move in a 2 dimensional space. A robot leg has 2 bending points consisting of 2 MG995 servo motors. So the robot contains 8 servo motors. Maximum weight of arobot leg is 2.0 kg. The front sonar sensor allows the robot to detect obstacles.

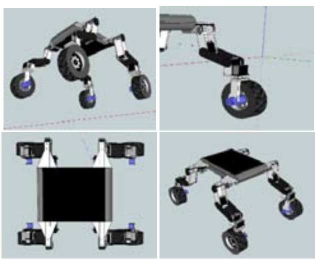

Figure 1:Different 3D views of the robot

As a result, the ATR is capable of overcoming different situations such as step climbing, inclined planes, obstacles in the path etc. Apart from that when the wheel touches the ground, the current changes trough the motor will be analyzed in order to make sure that it touches the step.

3. DESIGN

The ATR is designed to travel in different locations using two separate methods. Those are by wheels and by the bending movements of the robot leg. Wheels are used to do bidirectional movements and turning. Bidirectional movements are done by rotating all the wheels in a single direction at the same time as shown below.

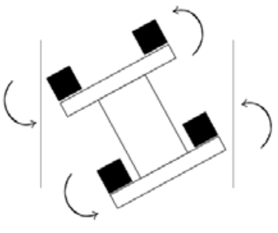

Figure 2: Turning left

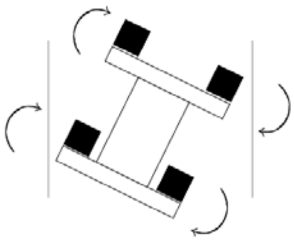

Figure 3: Turning right

Major use of the bending operations of robot leg is to climb steps. The servo motors are used to bend the robot leg at specific joints. How the step climbing process is done, is mentioned bellow.

FL = Front Left Leg
FR = Front Right Leg
RL = Rear Left Leg
RR = Rear Right Leg

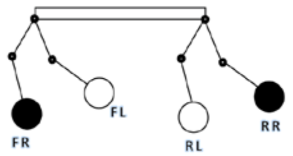

Figure 4: Preliminary design

First the front right leg is lifted over the step and just after it touches the surface, the body is lifted to a higher position to get enough space to lift the other front leg. After getting both of the front legs over the step, rear leg movements will be started. According to the above figures it proceeds.

And this is how it goes on an incline plane. In order to reduce the center of gravity and increase the stability of the robot it transforms in to this mechanism.

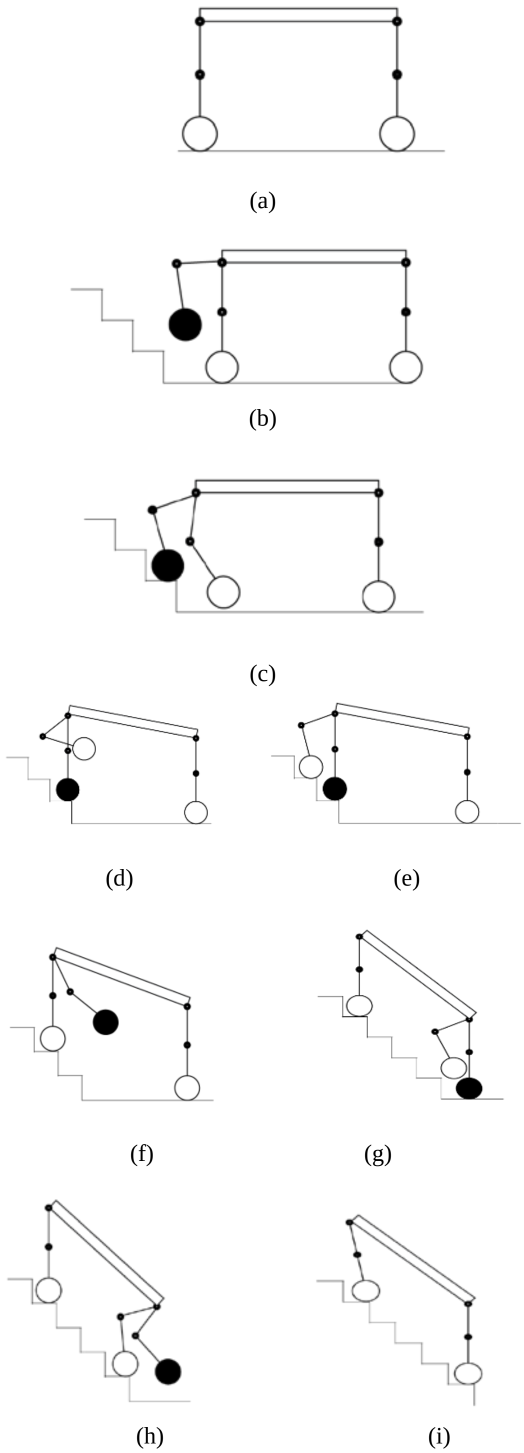

Figure5: Step climbing mechanism

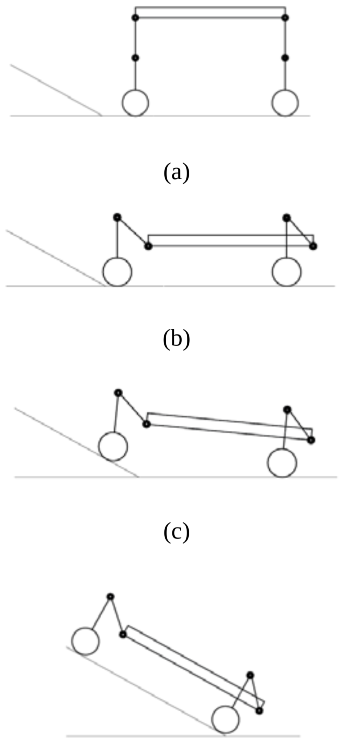

Figure 6: Incline plane traveling mechanism.

4. IMPLEMENTATION

In order to design this robot the following components have used.

	Specifications	
Component	**Voltage**	**Max. Current**
4 x PWM gear motors	3.0 - 6.0 V	60 mA
8 x MG995 – 180^{o} Servo motors	4.9 V	800mA
Sonar Sensor	5.0 V	10 mA
Li – Po Battery (2200 mAh)	11.1 V	5 A

Figure 7: Specifications of components

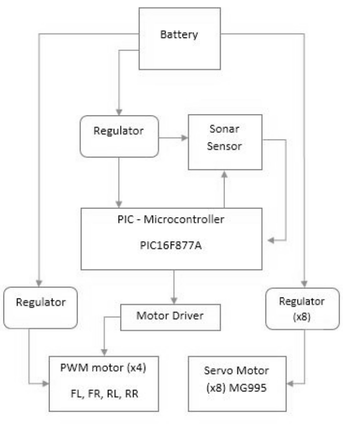

Figure 8: Block diagram

In this phenomenon, 8 individual regulators have used for each MG995 servo motors since those motors are needed high current as 800 mA.

5. RESULTS

After developing the robot below mentioned graphs were calculated. Then it's easy to consider the limitations of this robot.

In order to measure the maximum torque that a leg can be bared, there are 2 different graphs which are Figure 9 and Figure 10.

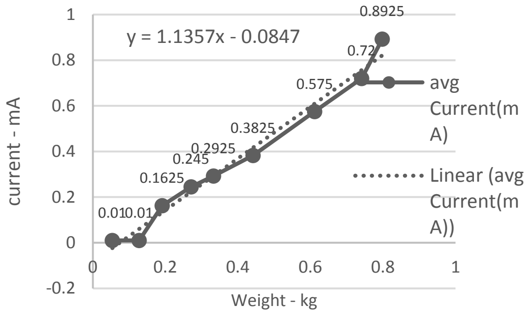

Figure 9: Weight vs angle

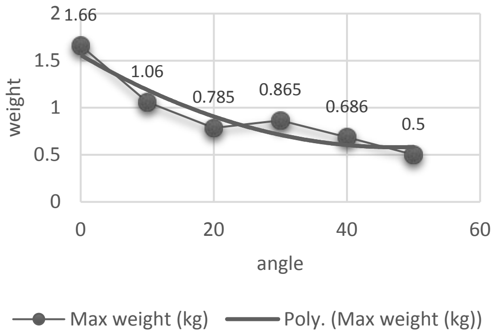

Figure 10: Weight vs current

These experiments were helped us to calculate different dimensions. The weight balancing also done by using these limitations. When the robot is turning it must turn about the horizontal center of the robot. Otherwise the stability will be reduced due to moving mechanism. Even the internal battery and the main circuit board were placed according to these limits.

6. CONCLUSION.

The development of ATR is used to overcome the obstacles (steps, stairs, etc.) while moving. The developed ATR's leg is able to withstand about 800g weight. The future recommendation for this ATR is to improve wheels and off-road feature. This can be achieved by maximizing the traction forces, which is equivalent to minimizing the function of wheels. Finally we must improve the performance and abilities of this robot to overcome more obstacles. Finally as a future plan robot will be able to go through any incline plane keeping the base plate in a stable horizontal position. This will be adjusted automatically using a gyroscopic sensor. Then this robot will be more useful for the people to achieve various tasks.

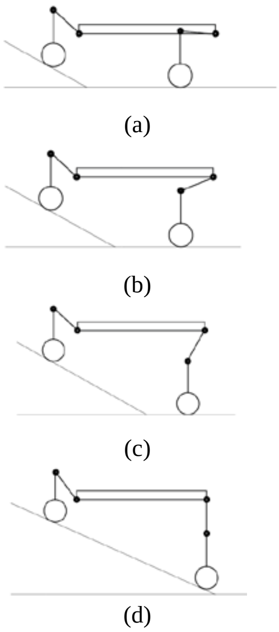

Figure 10: Travelling through an incline plane with horizontal base plate

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