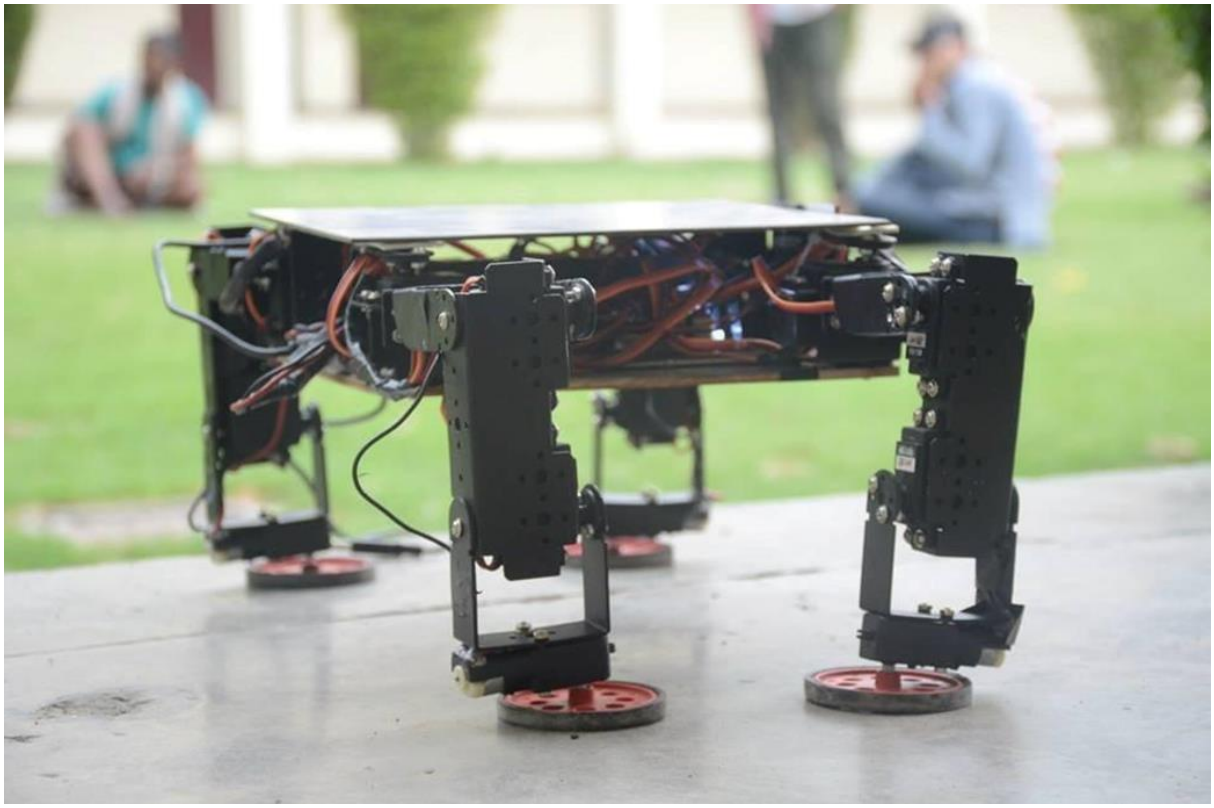
Transformer: 4 Legged Multi Terrain Robot



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Acknowledgement

This project has been done under Robotics Club, IIT Kanpur by 4 1st Year undergraduate students namely Ayush Poddar, Harshit Lathi, Anirban Manna and Yugesh Kumar. This project would not have been possible without the help and mentorship of some senior members of Robotics Club namely Shubham Patel, Rishi Gupta, Akshay Masare, Deep Goel, Hardik Soni and Pranav Vyas.

Abstract

All-terrain vehicles are generally based on either rolling or walking mechanism. The idea behind this project is to build an All-Terrain Vehicle which combines rolling and walking mechanism.

The 4 Legged multi terrain robot consists of four leg-wheel hybrid units which can transform between the two mentioned mechanisms. Servos and motors are used to actuate these units. Each unit has 4 degrees of freedom. The robot is programmed to transform according to the terrain automatically. All programming has been done on Arduino Mega

Content

Introduction

Transformer: 4 LEGGED MULTI TERRAIN ROBOT is a project completed in Summer Camp'14 under Robotics Club, IIT Kanpur. This project justifies its name "Transformer" as the robot can change its orientation according to its environment such as traversing through narrow passage, crawling on a rough surface, climbing a slope and changing its height.
The robot has 4 legs and each leg consists of 4 servos and 1 DC motor. Each leg has 4 degrees of freedom making it capable of transforming so as to perform the afore-mentioned tasks.
The robot is controlled via Arduino Mega and it is driven using a Bluetooth module.

Mechanical

Design:

Designing is the most important aspect of a robot. Hence, a 3-D design of the robot was initially worked out on Autodesk Inventor. The robot has 4 leg-wheel hybrid each consisting of 4 servos, 1 motor and 1 wheel resulting in 4 degrees of freedom. The following images shows the final design of the arm and robot.

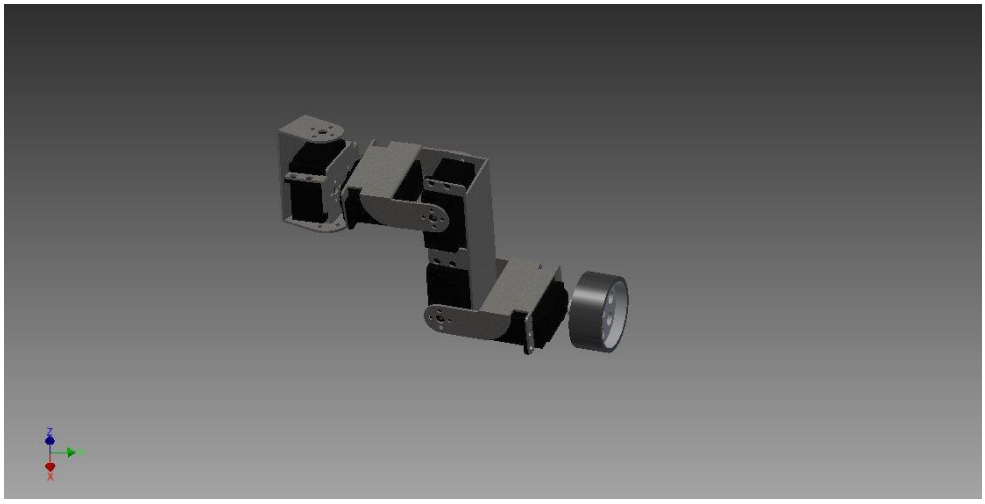


Fig: Design of the leg wheel hybrid

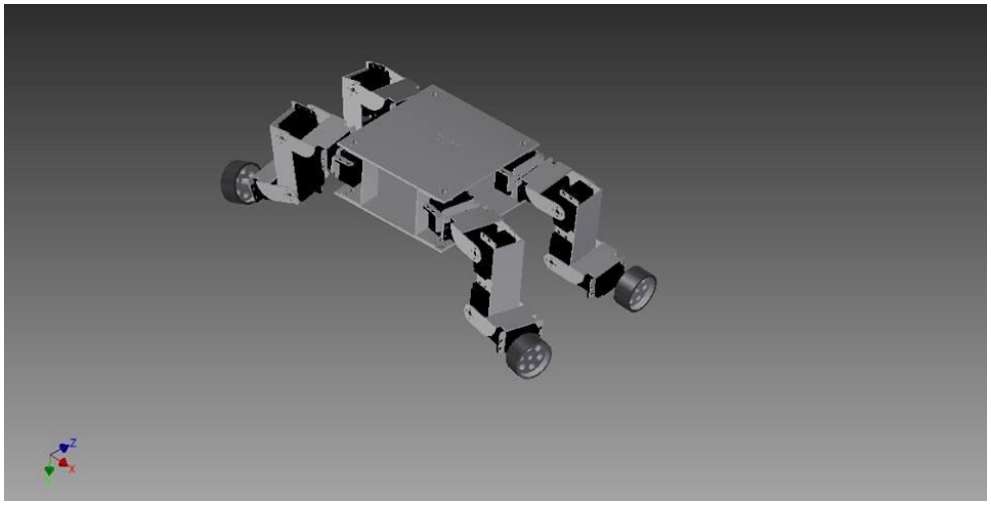


Fig: Design of the robot

Servo:

A servomotor is a rotary actuator that allows for precise control of angular position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

Servomotors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system.

Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

The following diagram is of the servo that is used in the project.

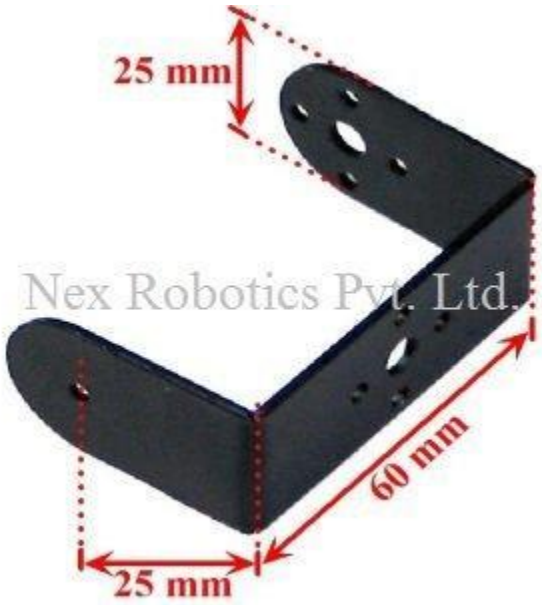
Specifications:

Dimensions: 40.8 × 20.1 × 38 mm
Weight: 56 g
Operating Speed: 0.18sec/60degree (4.8V)0.16sec/60degree (6V)
Stall Torque: 14kg.cm/194.8 oz.in (4.8V) 15.5kg.cm/215.6oz.in (6V)
Operating Voltage: 4.8V~6V
Control System: Analog
Direction: CCW
Operating Angle: 180degree
Required Pulse: 500us-2500us
Gear Type: Metal
Motor Type: Carbon
Connector Wire Length: 30 cm

Servo Brackets:

Aluminum servo brackets were used to mount the servos. The various types of servo brackets that were used are shown below.

1. C Bracket: It is connected to the end of the servo motor. It is compatible with all standard size servo motors.



Material: Aluminum
Thickness: 1.5 mm
Weight: 12 g

2. Universal Servo Bracket: It is used for holding standard sized servo motor. It is used with other brackets to create interesting links. It is one of the most popular servo bracket in use. It is compatible with all standard size servo motors.

Material: Aluminum
Thickness: 1.5 mm
Weight: 13 g

3. Universal Inline Dual Servo Bracket: Used for holding two servo motors straight line. It can be used for creating pretty interesting link designs.

Material: Aluminum
Thickness: 1.5 mm
Weight: 32 g

Chassis:

The chassis is made of plywood coated with glass fiber. Glass fiber was used to make the robot as light and strong as possible.
Dimensions**:** 30cm x 25cm x 0.2cm
Type of fiber glass: Polyester resin (Not reinforced)
Specific gravity: 1.28
Tensile strength MPa (ksi): 55 (7.98)
Compressive strength MPa (ksi): 140 (20.3)

Electronics

The following electrical components were used in the robot:

Motor Driver:

A motor driver is a device or group of devices that serves to govern in some predetermined manner the performance of an electric motor. A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and faults. 8V-28V, 5Amp Dual DC Motor Driver with Current Sense can drive 2 DC motors with current up to 5Amps. It can work between 8 to 28V DC and gives current sense output for each motor. Motor driver has built-in protection from over temperature, over current, short circuit. It also gives out fault indications for the over/under voltage, over temperature, over current / short circuit. Motor driver has 6-pin removable XY connector on the power side and separate 6 pin 2510 replicate connectors for logic connections of each motor driver section. Motor driver can drive 2 motors with peak load of 5Amps. If temperature of the motor driver goes beyond 1500C motor driver will restrict maximum output current to 4Amps. When temperature of the motor driver reaches above 1700C motor driver will shut down. You need to restart motor driver to resume operation. If output current exceeds 6.5Amps the motor driver will turn off the motor driver output to protect it against short circuit.

Arduino Mega:

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments. The hardware consists of a simple open hardware design for the Arduino board with an Atmel AVR processor and on-board input/output support. The software consists of a standard programming language compiler and the boot loader that runs on the board. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software running on a computer (e.g. Flash, Processing, MaxMSP)

LM7806:

The **78xx** (sometimes **L78xx**, **LM78xx**, **MC78xx**...) is a family of self-contained fixed linear voltage regulator integrated circuits. The 78xx family is commonly used in electronic circuits requiring a regulated power supply due to their ease-of-use and low cost. For ICs within the family, the *xx* is replaced with two digits, indicating the output voltage (for example, the 7805 has a 5 volt output, while the 7812 produces 12 volts). The 78xx line are positive voltage regulators: they produce a voltage that is positive relative to a common ground. There is a related line of **79xx** devices which are complementary negative voltage regulators. 78xx and 79xx ICs can be used in combination to provide positive and negative supply voltages in the same circuit.

78xx ICs have three terminals and are commonly found in the TO220 form factor, although smaller surface-mount and larger TO3 packages are available. These devices support an input voltage anywhere from a few volts over the

intended output voltage, up to a maximum of 35 to 40 volts depending on the make, and typically provide 1 or 1.5 amperes of current (though smaller or larger packages may have a lower or higher current rating). In this project we have used 7806 to convert 7.4 volts to 6 volts. Four 7806 has been used in this project and each 7806 provide power to 4 servos.

Bluetooth Module:

Bluetooth is a wireless technology standard for exchanging data over short distances (using short-wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz from fixed and mobile devices, and building personal area networks (PANs). Invented by telecom vendor Ericsson in 1994, it was originally conceived as a wireless alternative to RS-232 data cables. It can connect several devices, overcoming problems of synchronization.

Bluetooth is managed by the Bluetooth Special Interest Group (SIG), which has more than 20,000 member companies in the areas of telecommunication, computing, networking, and consumer electronics. Bluetooth was standardized as **IEEE 802.15.1**, but the standard is no longer maintained. The SIG oversees the development of the specification, manages the qualification program, and protects the trademarks. To be marketed as a Bluetooth device, it must be qualified to standards defined by the SIG. A network of patents is required to implement the technology, which is licensed only for that qualifying device.

Programming & Communication

Arduino Mega was programmed using the software Arduino 1.0.5. The programming language that was mostly C++ while few inbuilt syntax of the software has been used. The communication between computer and Arduino was done at a Baud Rate of 9600 Bd. Putty was used to establish the serial communication.

The code can be found in the following link:

https://drive.google.com/folderview?id=0B86ufPFYJVAUQVVjX25UQUdhWWc&usp=sharing

Conclusion

Future Scope:

The next phase of the project will be to make this robot fully autonomous by installing sensors so that it can detect terrain and transform accordingly.

Video Link:

https://www.youtube.com/watch?v=6tD3dsDzbeg

References:

1. https://www.youtube.com/watch?v=6tD3dsDzbeg
2. http://www.electrical4u.com/servo-motor-servo-mechanism-theory-and-working-principle/
3. https://www.**arduino**.cc/