HEXAPOD AS A ROVER USING RF TECHNOLOGY WITH ARDUINO MICROCONTROLLER

[1]A. SAI KRISHNA, [2]Y. DEEPTHI REDDY, [3]P. MANI KUMAR, [4]N. ANUPAMA RANI

[1,2,3]U.G Student, [4]Assistant Professor
[1,2,3,4]Electronics and Communication Engineering,
[1,2,3,4]Sreenidhi Institute of Science and Technology, Hyderabad, India

Abstract: **This paper focuses on the design, building, and control of a six-legged walking robot known as a hexapod. Main objective to design hexapod is that they have high flexibility and stability even in rough surfaces. Even in terrain regions they can move efficiently with good stability. The hexapod was fully fabricated with the 3D printed parts using PLA material. The nrf module, which employs RF technology, establishes communication between the transmitter and receiver. Hexapod is primarily made up of a microcontroller that serves as a control unit. The joystick is an input module that allows the user to steer the robot in the desired direction. The outputs from transmitter are converted into servo motor commands for leg movement. The microcontroller's instructions will assist in the operation of the motors. There will be a wireless communication between a joystick and a hexapod utilising a nrf module.**

IndexTerms **– Hexapod, Joysticks, Transmitter, Receiver, 3D printing Tripod gait.**

I. INTRODUCTION

The importance of using a robot cannot be overstated, given the numerous natural disasters that occur all over the world. In a crisis event, a robot that is commanded by a person or that operates autonomously can be deployed. Because of its flexibility and stability while moving on any sort of surface, the hexapod robot is one of the robots employed in this situation. A six-legged robot is known as a hexapod robot. The necessity of using a robot cannot be contested because there are many natural ways to move or walk. Because the Hexapod has six legs, it's simple to teach it to move around because it can be adjusted to a variety of gaits utilizing radio frequency technology and the Nrf module.

The chassis is one of the most critical components of a robot. Wheeled, tracked, and legged chasses are the three main chassis types. Wheeled chasses are quick, but they aren't designed for tough terrain. Tracked chasses are slower, but they are better suited to rough terrain. Legged chasses are slower and more difficult to manage than four-legged chasses, but they are exceptionally tough in rocky terrain. Legged chasses can cover huge gaps and continue to hunt even after losing a leg. Legged chasses are particularly well-suited to space missions.

Design of Hexapod consists of body and legs. Lightweight composite materials make up the primary body. It lowers the project's overall cost. The legs are fixed at opposing ends to preserve the center of gravity at the mid-point of the body, allowing the robot to move constantly and balance itself. The robot's legs each have the same functions and six degrees of freedom. The motion algorithm is the only variation between the legs. The legs are constructed in such a manner that it can walk on uneven surfaces and climb up steep slopes.

The body architecture of hexapod is rectangular. The architecture of the hexapod robot is determined by the reasons and applications for which it is necessary, such as terrain shape, workspace, and payload. According to the findings, a variety of leg kinds are used for hexapod walking robots depending on their uses. In order to build a hexapod with enough stability to endure motions on irregular and rough surfaces, this model employs a total of 18 servos. A servo must first be initialized before it can be synchronized. As a result, each of the 18 servos is individually set to a certain angle.

II. DESIGN

2.1 Mechanical Design:

Initial goal is to create 3D model of Hexapod. So, it is first designed in Autodesk fusion 360 software. After designing in software, the designs are exported for 3D printing. PLA material is used for printing the parts. 3D printing use a layering process to produce three-dimensional things using computer-aided design. After 3D printing, the printed parts are assembled as designed in software.

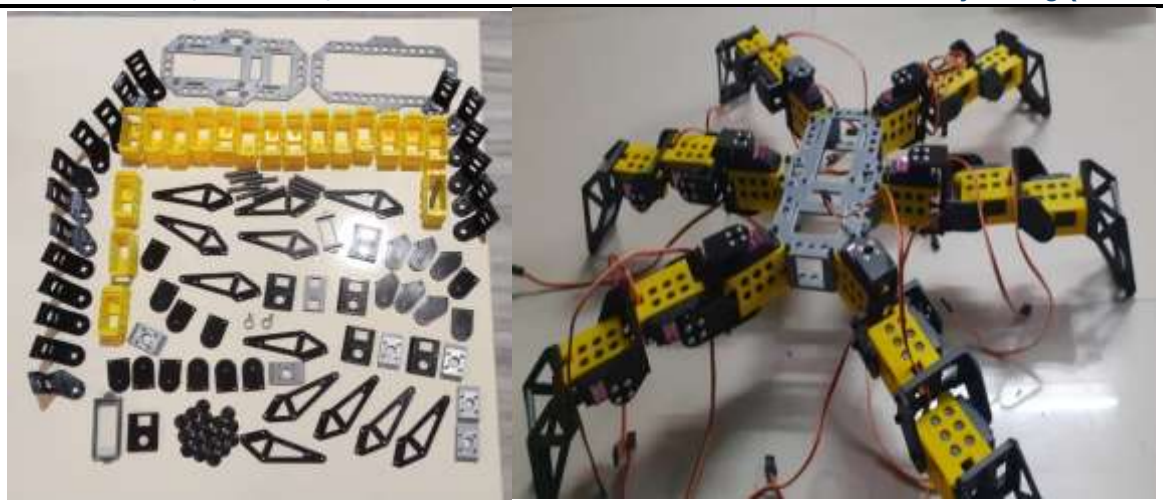

Fig.1 3D printed parts and assembled hexapod

2.2 Assembly of Hexapod:

2.2.1 Body Assembly:

The hexapod's body bottom and top are connected by six body risers, four of which are in the body's corners and two at the sides. With the assistance of bolts, one Servo mount is linked to each body riser. The 6 servo mounts are attached to the 6 servos. This Servo aids with horizontal leg movement, such as front and back movement. Coxa is the name given to this movement. The coxa joint is formed when the coxa bracket is attached to the servo shaft. The bearing at the bottom of each servo mount is linked to the servo bearing centre cap. The end cap of the coxa bracket is attached to the coxa bracket and the servo bearing centre cap. Wire guides are installed at the top of the body and are used to organise the wires. The receiver and microcontroller are held in place by the receiver holder and the sbec holder.

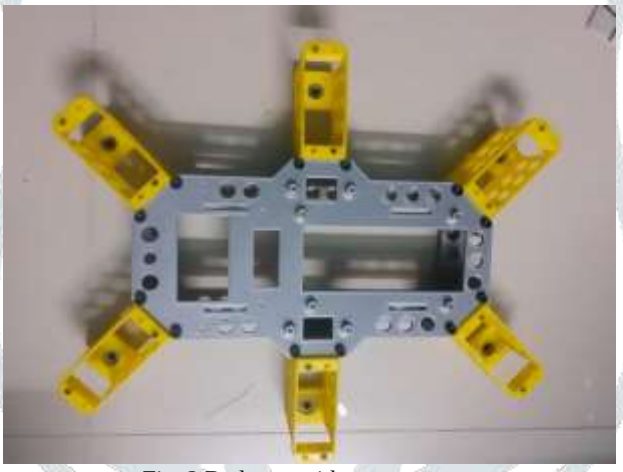

Fig. 2 Body top with servo mounts

2.2.2 Legs Assembly:

Femur bracket is connected perpendicular and at the center to each coxa bracket. One servo is installed in the six servo mounts and Servo mount Consisting of servo is connected to the each of the femur bracket with the help of servo shaft. This servos help in the vertical movement of the leg i.e. up and down. This movement is called Femur movement and the joint is called as Femur joint. Servo bearing center cap is connected to the bearing present at the bottom of each servo mount. Femur bracket end cap is connected to the femur bracket and servo bearing center cap.

Servo mount at femur joint is connected to tibia bracket. One servo is installed in the six servo mounts and servo mount Consisting of servo is connected to the each of the tibia bracket with the help of servo shaft. This servos help in the height adjustment of the leg i.e. increasing and decreasing height of the entire body. This movement is called tibia movement and the joint is called as tibia joint. Servo bearing center cap is connected to the bearing present at the bottom of each servo mount. Tibia bracket end cap is connected to the tibia bracket and servo bearing center cap. Tibia base plate is connected to the tibia servo mount. Two tibia side plates i.e. tibia left side plate and tibia right side plate, is attached to the sides of the tibia base plate. In between of the tibia side plates, a tibia space tube and tibia foot plate is fixed to increase the stability and toughness of the leg. A tibia foot bumper made of rubber is attached to the tibia foot plate. It acts as a shock absorber to the leg.

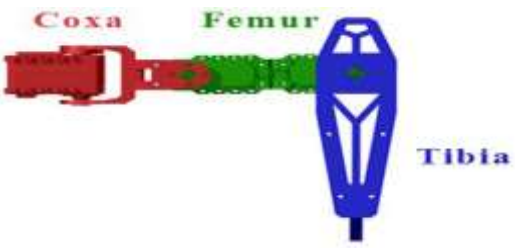

Fig. 3 Hexapod Leg

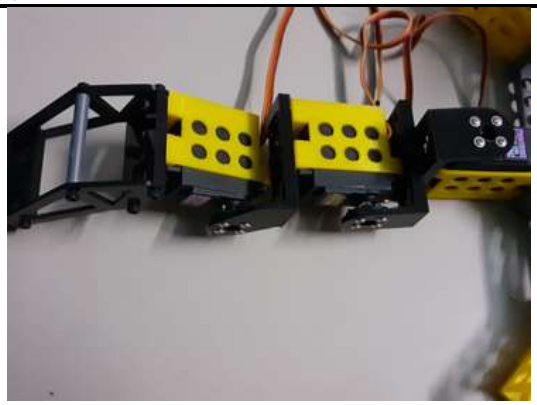

Fig. 4 Assembly of one leg

2.3 Block Diagram:

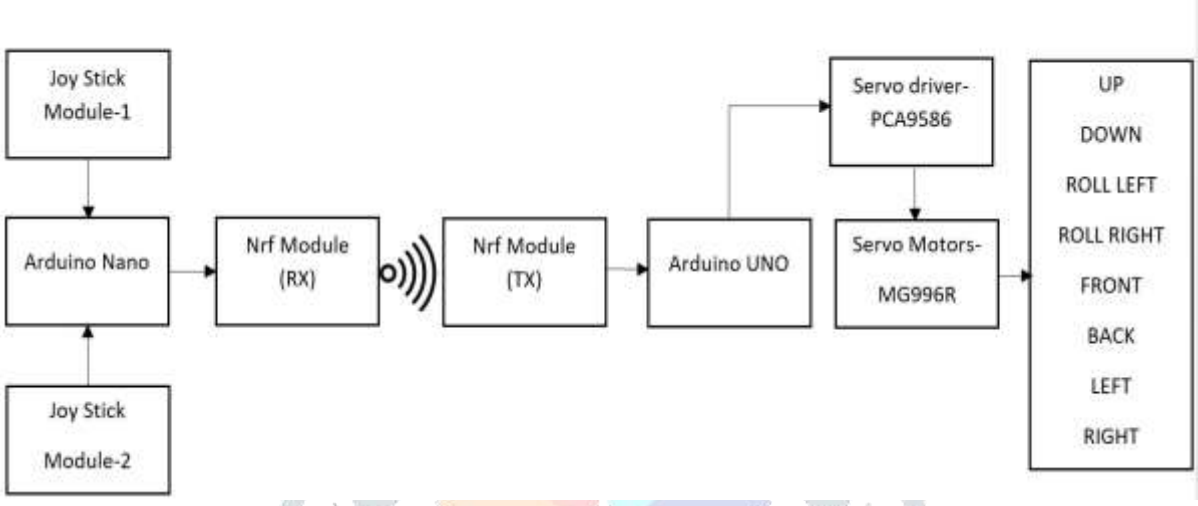

Fig. 5 Block Diagram

III. WORKING

Our design of hexapod is a manual controlled robot. It is controlled using a transmitter by the operator or user, uses a self-built transmitter built by our team. The project contains two levels- transmitter and receiver. Communication between Transmitter and receiver is established using nrf module which uses RF technology. A hexa-bit address will be stored in the transmitter and the receiver which helps them to bind for communication.

Hexapod mainly consists of a microcontroller which acts as a controlling unit. Joystick is used as an input module that controlled by the user to move the robot in desired direction. The instructions from the microcontroller will help to run the motors. Their will a wireless transmission using nrf module between a joystick and hexapod. Hexapod has two parts- Transmitter and Receiver.

3.1 Transmitter

Transmitter consists of three blocks – joystick block, micro controller block, and nrf block. The robot is intended to move on all terrain. For this reason, joy sticks are used for ease control of the hexapod. Thus, the robot can be sent to the desired location. Since the robot moves in two dimension in the x-y plane, a controller for trajectory control on the x-axis and a second controller for control on the y-axis are used. So the motion control of the robot on these trajectories has been done by using joysticks. There are two joysticks in the transmitter- joystick1 and joystick2. Using joystick1 user can control front, back, left and right. Using joystick2 user can control roll left, roll right, height increase and height decrease. Whenever user controls the joysticks it sends an analogue signal to the micro controller. It will be mapped to the desired data of information which will be ready to transmit through the nrf module by the microcontroller.

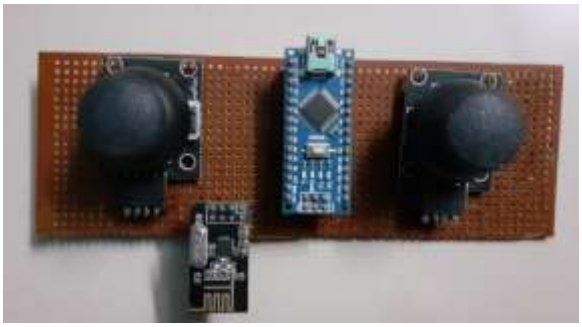

Fig. 6 Transmitter of the hexapod

3.2 Receiver

The mapped data sent from the transmitter gets received at the receiver nrf module. It is decoded in the microcontroller. Data decoded with the help of microcontroller received by the pca9685 servo driver and desired locomotion of the hexapod is executed. The tripod gait was used for the stepping motion of the robot. Wave stepping is a form of walking motion that is commonly used in spider robots. Each leg of the robot has three joints. There are servo motors in these joints to provide movement. All of these servo motors are centred at an angle of 90 degrees during assembly. We constructed a hexapod robot during this project. This hexapod has rectangular body type – it has two groups of legs, three on each side. Each leg has three degrees of freedom.

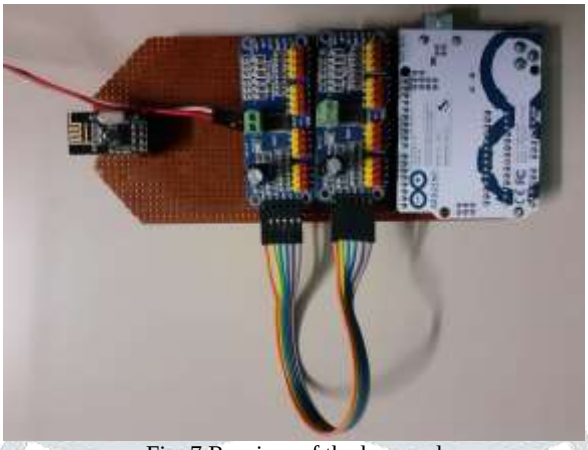

Fig. 7 Receiver of the hexapod

The coxa joint in the legs connect the foot to the body of the robot and at the same time move it back and forth in the x-y plane. The femur joint performs the up and down movement of the foot in the x-z plane. The tibia joint performs the height increase and decrease movement of the body x-z plane. In the basic robot movement, firstly, two joints in the 1st, 3rd and 5th legs are given a sinus sign together, the joints of the 2nd, 4th and 6th legs having the same amplitude and frequency immediately after the contact of these legs to the ground sinus sign is applied. If the step angles on the 1st, 3rd and 5th legs are larger than the step angles on the 2nd, 4th and 6th legs, the robot moves in the x-direction and vice versa. The control mark of the controller controlling the movement in the x direction adjusts the pitch angles of the 1st, 3rd and 5th legs, and the control mark of the controller in the y-direction adjusts the step angles of the 2nd, 4th and 6th legs.

Fig. 8 Hexapod robot and tripod gait motion.

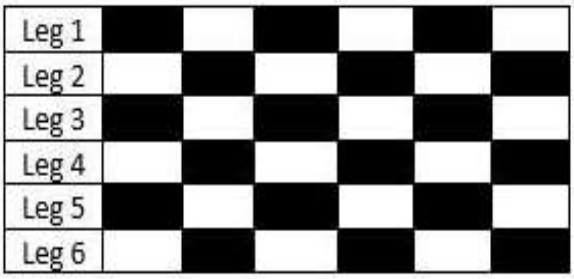

Fig. 9 shows tripod gait movements.

Circuit Diagram
Transmitter

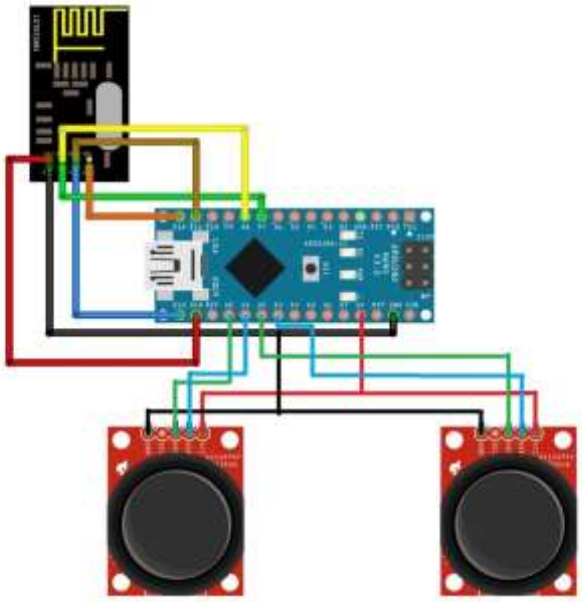

Fig. 10 Circuit Diagram of Transmitter

Receiver

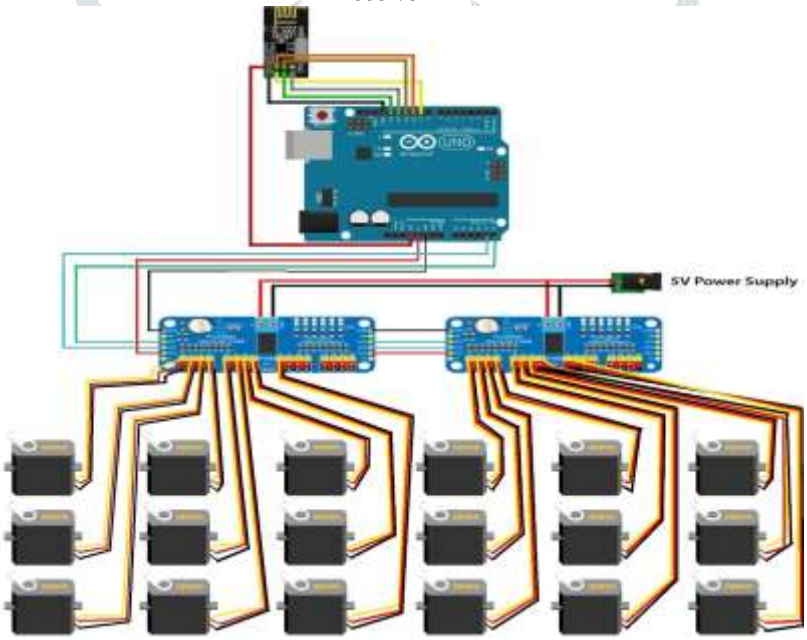

Fig. 11 Circuit Diagram of Receiver

III. OUTPUT

Hexapod robot was designed and constructed. The body of this hexapod is rectangular, with two sets of three legs on each side. Each leg has 3 DOF(Degrees of Freedom) and the coxa, tibia, and femur joints are all driven by servo motors. There will be the wireless communication between transmitter and the hexapod robot through RF technology up to 100 m. Two joysticks are used for controlling the moments of hexapod. Walking Algorithms are implemented to move Left, right, front, back, roll-left and roll right. These moments are achieved and performed by hexapod. Designed robot can move on both flat and rough surfaces. It is able to retain its stability while also overcoming any obstacles in its path.

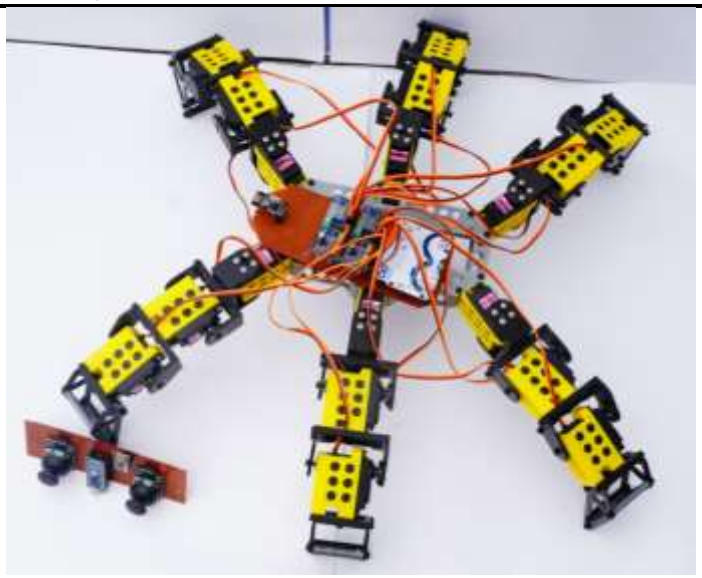

Fig. 12 Hexapod

V.CONCLUSION

Hexapod is six-legged walking robot which is designed by using RF technology and controlled by arduino microcontroller and operated by joysticks. Hexapods are mainly used for moving, precision positioning, aligning even in rough surfaces. In hexapods, leg mechanisms are used for locomotion and these are more versatile and can traverse in many different terrains. They can even reach dangerous places, mining, military regions. Hexapods have high efficiency and stability. Hexapods have wide range of applications. Further, Sensors for data collecting can be used to improve feedback and make the Hexapod's functioning more complicated.

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