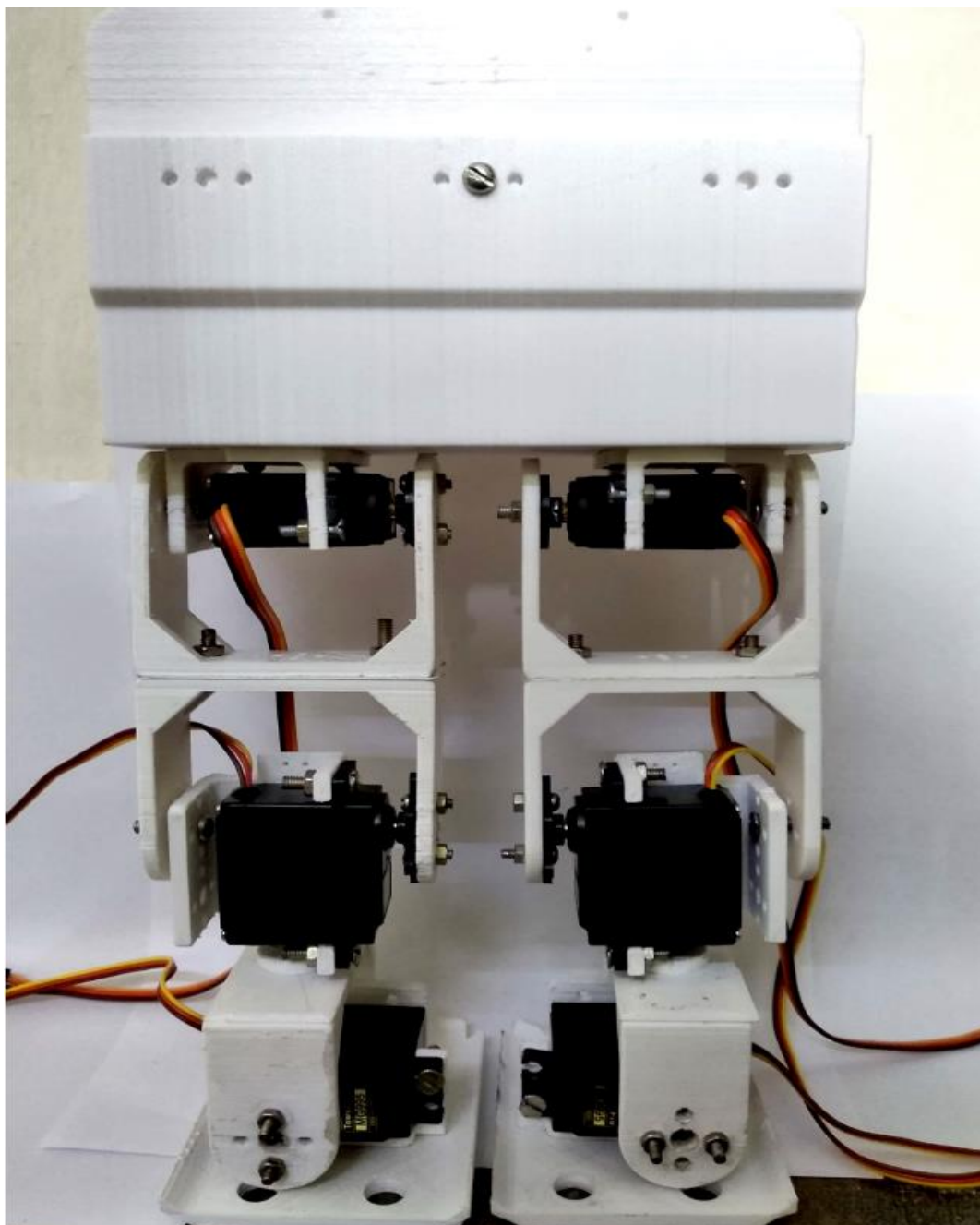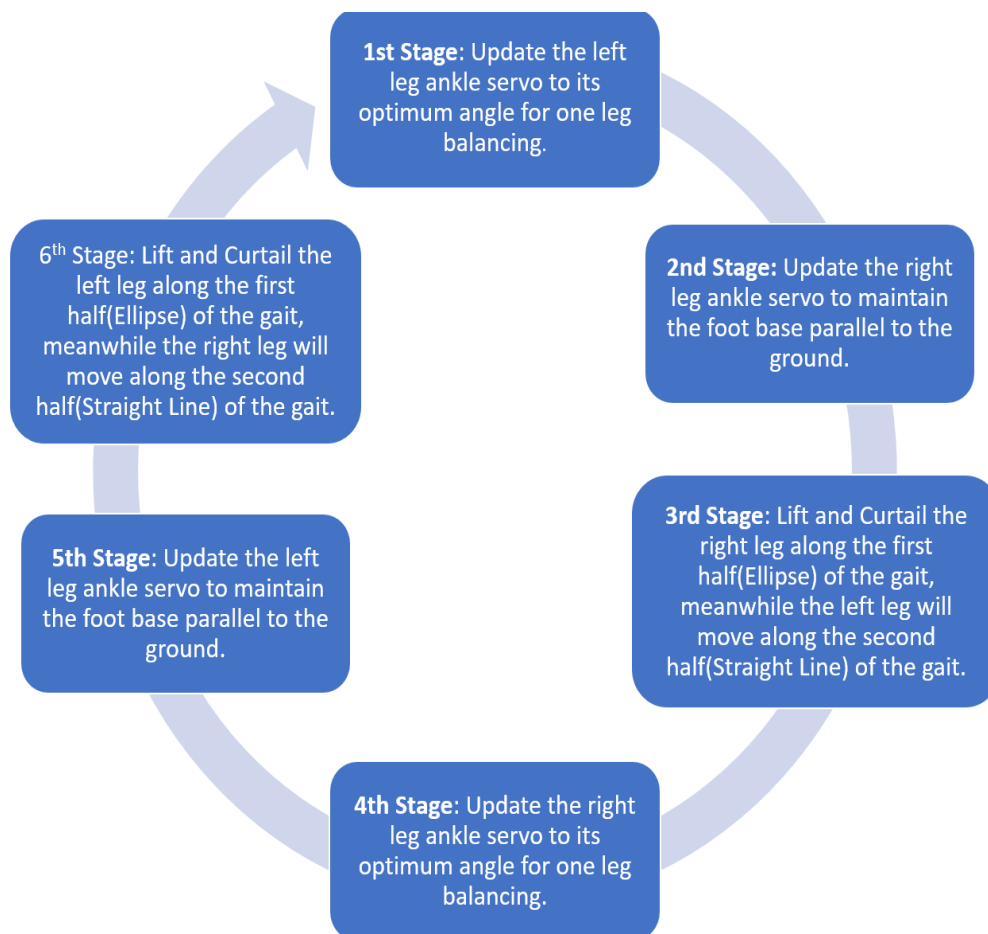# Srishti 2020

Models and Robotics Section

Bipedal Robot

Abstract

The Bipedal Robot is a humanoid robot modelled to mimic the walking of a human, the Robot is designed to have 6 degrees of freedom in total, implying 3 Degrees of Freedom in each leg, 2 of which are used for moving the leg in forward or backward direction using Servo motors at each joint(hip and knee), while the other degree of freedom is used for balancing the robot using another servo motor when standing on one leg, the mechanical model is designed to avoid extra weight so that the balance of the robot is more stable. The robot is actuated by using the microcontroller Arduino and using Li-Po rechargeable batteries of 11.1 Volts as the power source.

1st Stage: Update the left leg ankle servo to its optimum angle for one leg balancing.

2nd Stage: Update the right leg ankle servo to maintain the foot base parallel to the ground.

3rd Stage: Lift and Curtail the right leg along the first half(Ellipse) of the gait, meanwhile the left leg will move along the second half(Straight Line) of the gait.

4th Stage: Update the right leg ankle servo to its optimum angle for one leg balancing.

5th Stage: Update the left leg ankle servo to maintain the foot base parallel to the ground.

6th Stage: Lift and Curtail the left leg along the first half(Ellipse) of the gait, meanwhile the right leg will move along the second half(Straight Line) of the gait.

Motivation

Bipedal robots are able to move in areas that are normally inaccessible to wheeled robots, such as stairs and areas littered with obstacles that make wheeled locomotion impossible, also they can be an asset which can work in hazardous conditions.

Mechanical Aspect

Robot's size selection

Robot size plays a major role. Based on the cost of project, materials required for fabrication and the no. of actuators can be determined. In this project the size of the robot is preferred so a height of 300mm is decided which includes mountings of the control circuits, but the actual size of the robot is 230mm without controlling circuits.

Degrees of Freedom (D.O.F)

Human leg has got 6 degrees of freedom (Hip – 3 D.O.F , Knee – 1 D.O.F , Ankle – 2 D.O.F) , but implementing all the 6 D.O.F is difficult due to increase in cost of project and controlling of the actuators which become complex, so in this project reduced degrees of freedom is aimed so 3 D.O.F(Ankle , Knee and Hip) per leg has been finalized.

Link Design

In this project we have used U-shaped, L-shaped and multipurpose Servomotor brackets like arrangement made by 3D printers and material that used is PLA for joints formation, and reducing as much extra weight as possible.

Stability of the Robot

In order to achieve effective balance, actuator will be made rotate in sequence and the robot structure will try to balance. If the balancing is not proper, in order to maintain the Centre of Mass, dead weight would be placed in invented pendulum configuration with 1 D.O.F. This Dead weight will be shifted from one side to the other according to the balance requirement.

Foot Pad Design

The stability of the robot is determined by the foot pad. Generally, there is concept that oversized and heavy foot pad will have more stability due to more contact area. But there is a disadvantage in using the oversized and heavy foot pad, because the torque requirement of the motor is more and lifting the leg against the gravity becomes difficult. By considering this disadvantage an optimal sized foot pad was used. Dimensions of the foot pad are 75*70mm.

Electronic aspect

Power Source

11.1 Volts 2200mAh Li-Po battery is used as the power source for powering the Arduino as well as the Servo motors, for the Servo motors IC814 chips are used to convert the battery voltage to the rating value of the Servo motors as well as ensuring optimum current flow in all the motors.

Actuation

All the movement is actuated using Metal gear Servo motors, one motor is used for a single degree of freedom. The gait cycle of the robot is a combination of an ellipse as well as a straight line, when one half of the gait cycle is being executed of a certain leg then the other half of the gait cycle will be getting executed of the other leg.

Motor Selection

The choice of motors was based on the idea of reducing weight as well as creating a less complex feedback mechanism, hence the choice of using high torque metal gear position control DC Servo motors was appropriate under the given constraints.

<u>Microcontroller</u>

Arduino UNO R3 is used as the microcontroller which can operate six Servo motors at a time, enabling various types of motion such as forward, backward etc.

<u>Cost Structure</u>

Materials	Cost (INR)
6 DC Servo Motors	3000
Arduino UNO R3	400
11.1 Li-Po Battery	1800
Miscellaneous	300
Total	5500

<u>Applications</u>

1. The movement of the robot can be controlled by using a remote controller.

2. The bipedal robot can assist humans to carry out the tasks or activities in hazardous environment which could eliminate human's risk of injury or life casualty.

3. They can be used for household work for the disabled or someone suffering from any disease.

4. Prosthetics Walking machines can be used as walking aids for paraplegics or limb amputees. (Acosta-Marquez ´ and Bradley, 2000).

5. Agricultural work, a walking robot does less damage to the ground than a wheeled robot, and is also able to step over obstacles and move in complicated, non-smooth terrain.

Limitations

1. Currently the robot has only 6 degree of freedom, so the motion has some constraints.

2. The bot is battery operated with small power supply, so regular change of battery is required.

3. Computer Vision or Ultrasonic sensing is not enabled, which means object detection cannot happen.

Future Improvements

1. Size can be changed so as to human activities and task.

2. Degree of freedom can be increased to give proper flexibility in all directions and orientation.

3. Using Computer Vision for Obstacle detection, human recognition and corresponding Path planning.

4. Using IoT, this bot can be controlled from anywhere and can be live-streamed using webcam. It can be made autonomous using Machine Learning.

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