Gait Switching Lizard Robot

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Abstract

- The purpose of this project is to investigate the advantages in energy consumption and acceleration that some lizards experience during motion when they actively enter a bipedal gait before natural rearing can occur.
- Prior research suggests that this active transition to a bipedal gait may occur in certain lizards [5], but offers no insight as to what advantages this behavior may offer over rearing naturally.
- The team hypothesized that lizards could achieve higher acceleration and lower energy consumption by initiating active rearing during motion.
- To test the two aspects of our proposed hypotheses, we have designed and fabricated a robot capable of traveling in both quadrupedal and bipedal configurations.

Introduction

- **Problem Statement:**

1. **Emulate Quadrupedal to Bipedal Transition:**

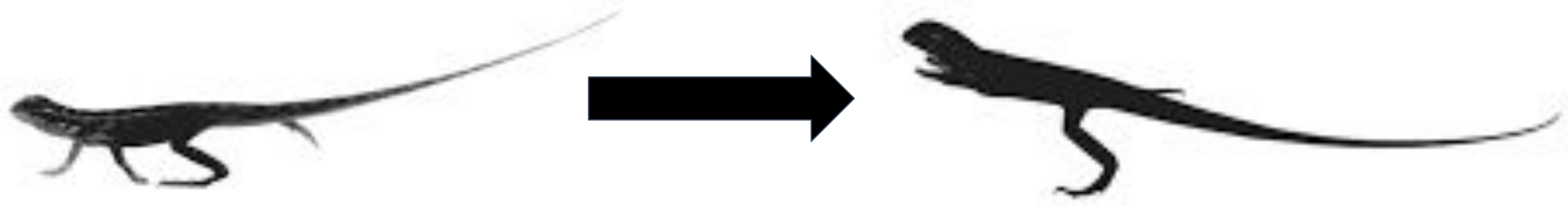

Fig 1. Bipedal to Quadrupedal Transition

2. **Stable Movement in Bipedal Gait:**

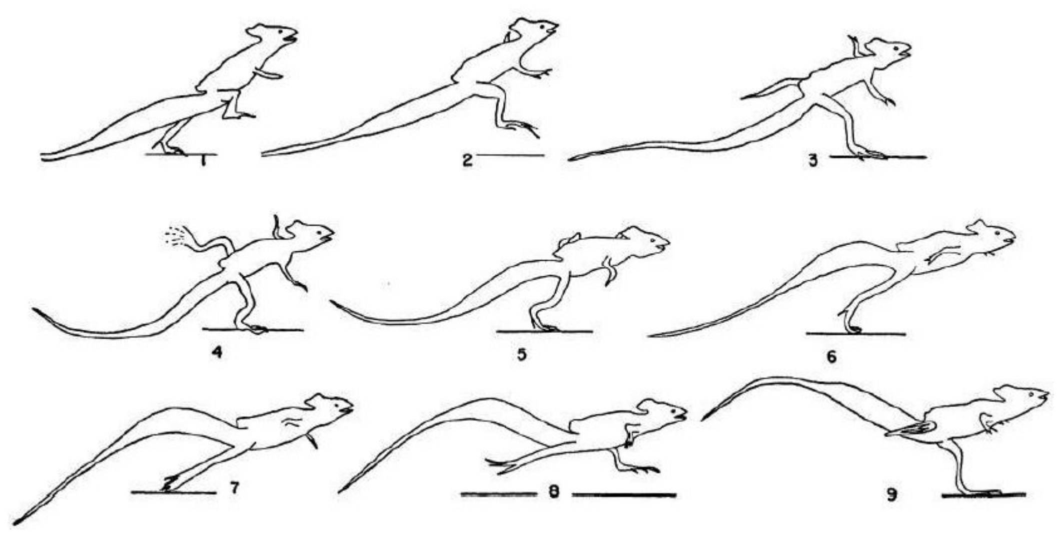

Fig 2. Movement in Bipedal Gait

This allows us to figure out the benefits of lizards actively entering into a bipedal gait while running.

- **Challenges for Bipedal Robots:**

1. **Weight Distribution:**

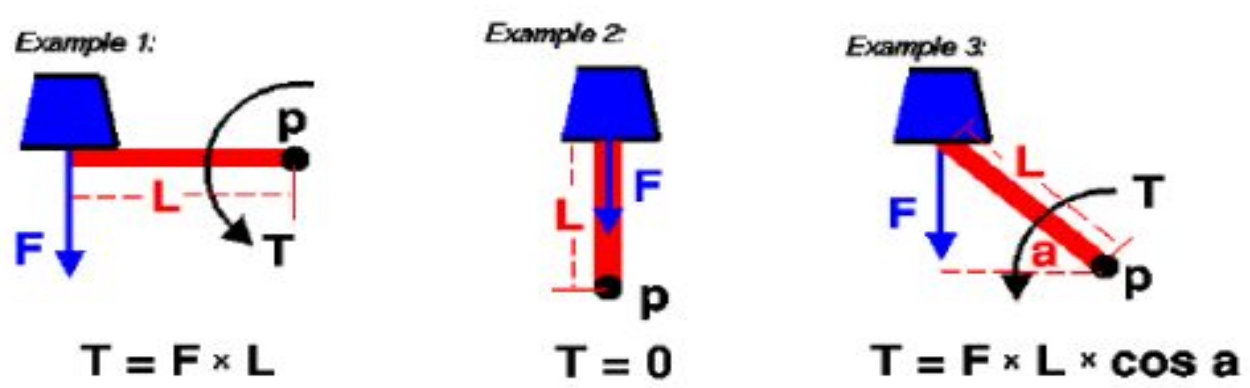

Fig 3. Rearing Stages

Torque required is proportional to the front weight, so we want COM to be as close to the back as possible.

2. **Balancing in Bipedal Mode**

Design

The robot is divided into four subassemblies:

1. **Front Section:** Our robot's front portion is actuated by a servo motor and contains a solenoid that strikes the ground to provide lift force. A linkage imitates the abdominal muscles that lizards use to rise into a bipedal stance.

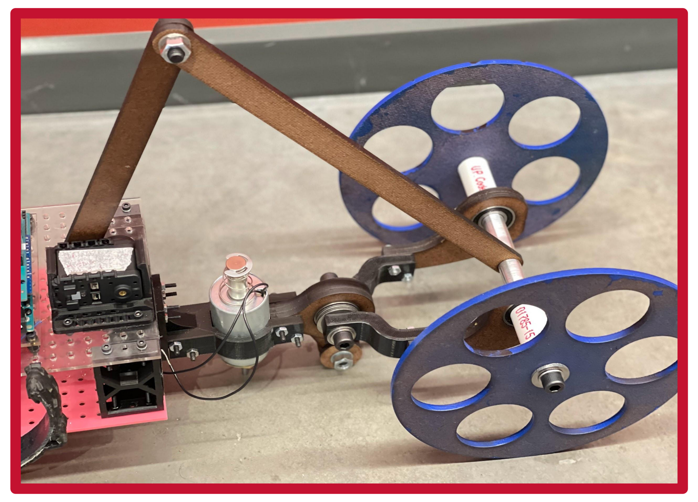

Fig 4. Front Section of Robot

2. **Main Body:** The main body consists of two laser-cut acrylic base plates affixed to one another. All electronics are mounted within PLA housings that are secured to the acrylic plates.

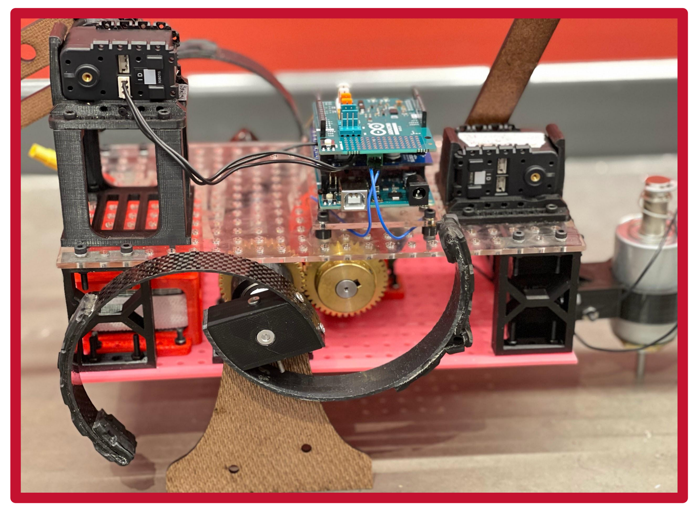

Fig 5. Main Body of Robot

3. **Legs:** Each rear leg mechanism is composed of 2 RHex legs joined to a PLA housing to form an S-shape. This design emulates the rapid, circular trajectory of lizard legs.

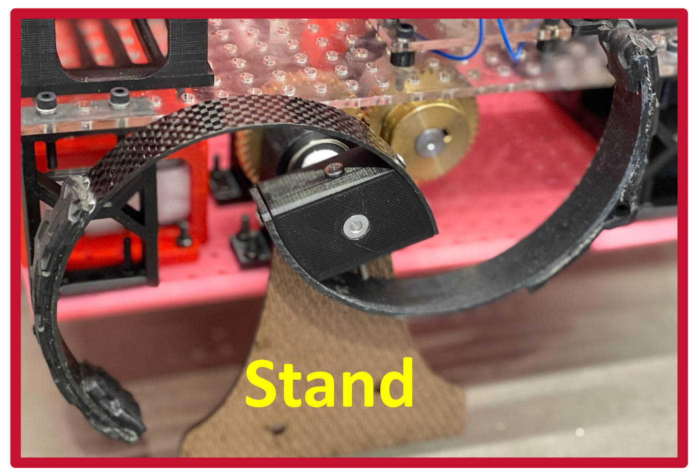

Fig 6. Legs of Robot

4. **Tail:** A servo-actuated tail is used to achieve stability control. When the IMU detects that the lizard body has reached a certain angle, the tail swings to assist the robot with rearing.

Fig 7. Robot Tail

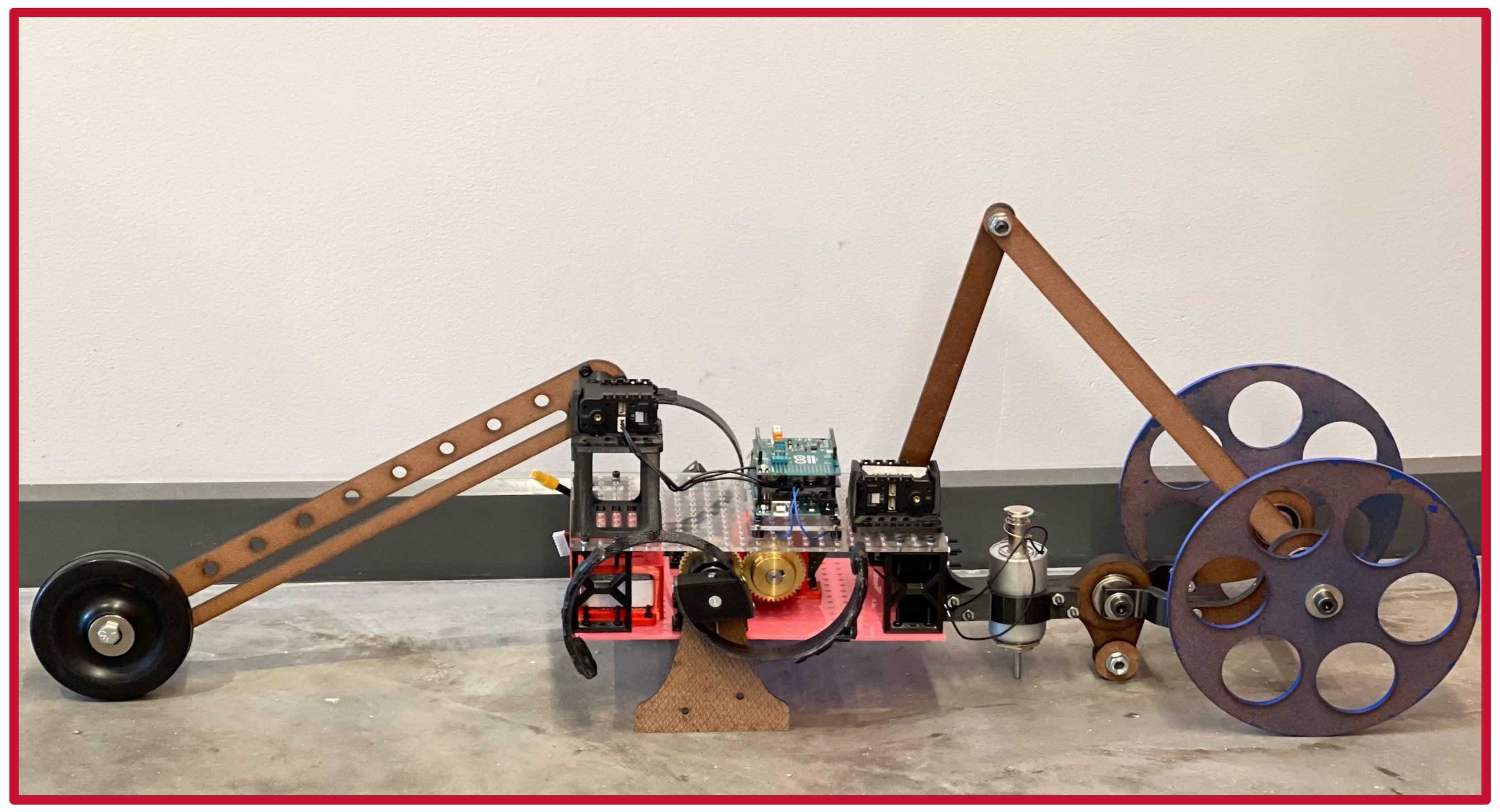

Fig 8. Complete Robot Assembly

Methods

Passive Rearing:

1. Mount the rear legs to the stands shown in Figure 6.
2. Attach a spring to the top of a block and place the front of the robot's main body onto the spring.
3. Allow the robot body to oscillate and then balance itself by actuating its tail, simulating passive rearing.
4. Measure the current drawn by the system using an oscilloscope.

Active Rearing:

1. Remove the block and command the robot to initiate active rearing by swinging its tail.
2. Check IMU output to ensure that the robot's body angle reached the desired value; discard trial if it did not.
3. Again measure the current drawn by the system.

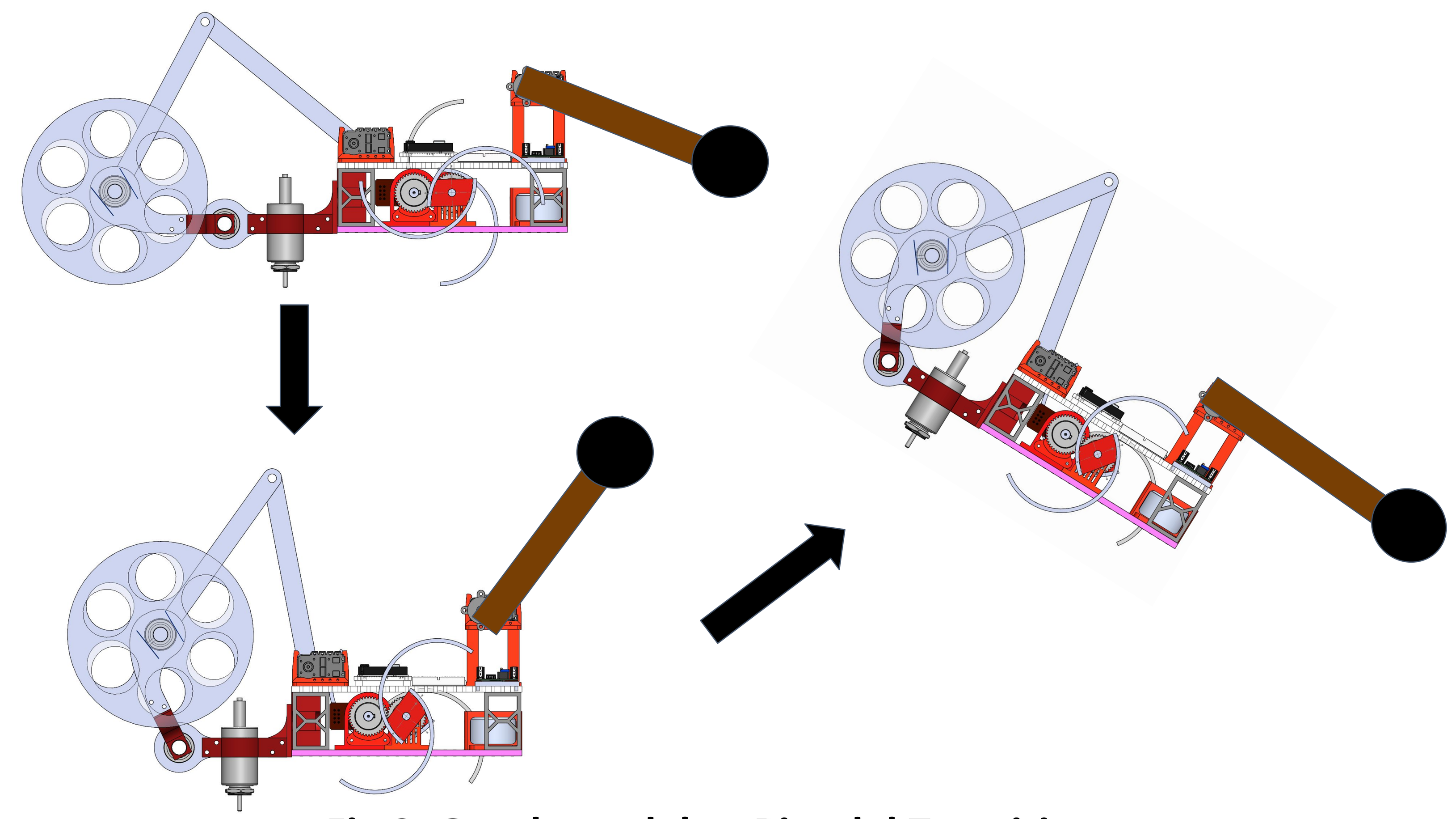

Fig 9. Quadrupedal to Bipedal Transition

Experimental Plan

Our hypotheses will be tested by comparing power usage between passive and active rearing. Average power usage for each method of rearing will be calculated from multiple trials. This data will be used to determine the duration of passive rearing for which active rearing becomes more energy efficient than passive.

Results

Check out our live demo and experimental results at our booth!

References/Acknowledgements

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[4] "Grumpy-Old-Tech", GOTPIDLoop, (2018), GitHub repository, https://github.com/Grumpy-Old-Tech/GOTPIDLoop

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