Homework 1: Animal Observations

24-775 Robot Design & Experimentation
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This assignment should be started during the virtual zoo visit. You can complete this assignment using the resources in the virtual zoo or youtube videos.

I completed my observations during:

☑ In-person Zoo Trip ☐ Other:

While exploring the zoo, identify two or more animal behaviors that are impressive, surprising, or clever. Think about how the animal's mechanical design (anatomy), controller (nervous system), and environment come together to make this capability possible. Then answer the following questions.

Animal 1

Name of animal: Dog

Describe the behavior that you found interesting:

Dogs have different gaits under different scenarios. While the dogs are walking, they always move the foots on the same side (Fig. 1). However while trotting, they tend to run with the foot in an alternative way (Right forelimb and left hind limb move in same direction, or left forelimb and right hind limb move in same direction) (Fig. 2). While they are running, both forelimbs will extend simultaneously to push the ground backward. Then both hind limbs will also move in this similar pattern to provide reaction force (Fig. 3). Hence the whole body will move forward quickly.

Draw a sketch, free body diagram, or keyframes to show the behavior:

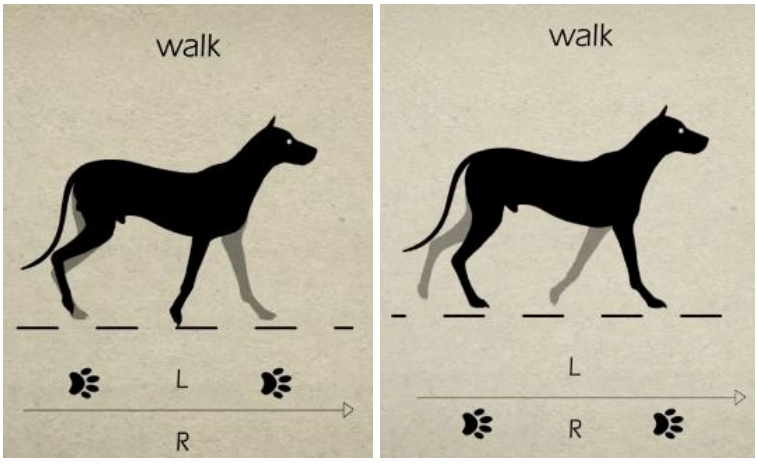


Fig. 1 Walking mode

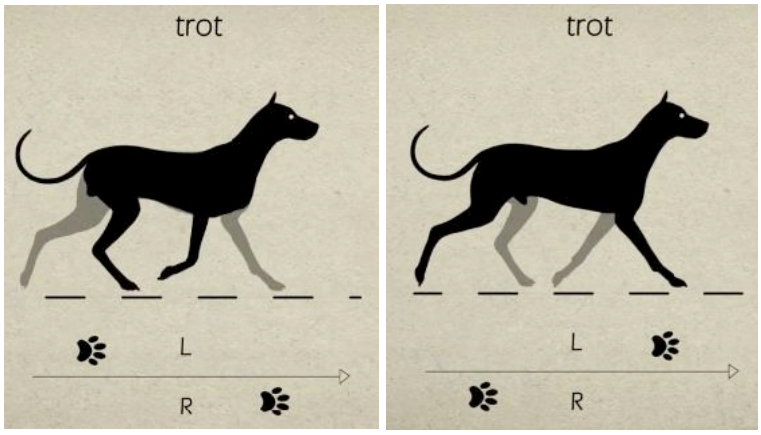


Fig. 2 Trotting mode

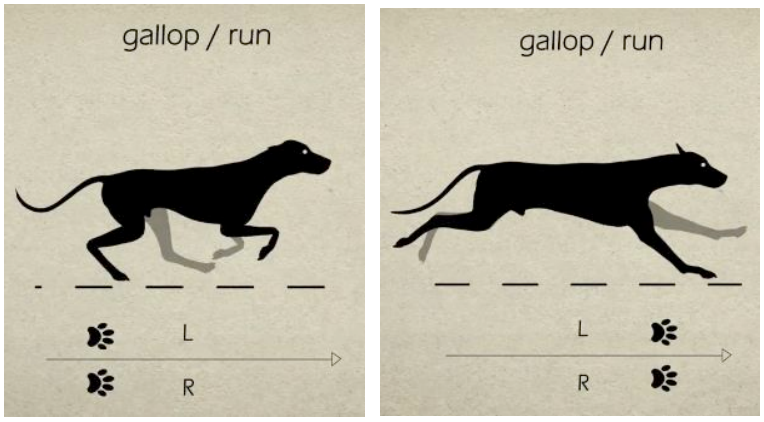


Fig. 3 Running mode

What do you think is the key factor (peak force, dexterity, precision, etc) that enables this behavior?

Perfect control and synchronization among limbs.

How could a similar capability help a robot?

Dog robot can decide its gaits for different scenarios like walking, trotting and running to maximize its energy efficiency (Energy vs Displacement), speed and stability.

Generate a research question or hypothesis about this behavior or its application in robotics. Rewrite the question or hypothesis 3 times.

Hypothesis: Dog robot walking or running in non-standard mode will have less energy efficiency than moving with natural/standard gaits.

Note:

Walking or running in non-standard mode means dog robot moves in different gaits from normal gaits

1. Dog robot walking in running gait or running in walking gait will consume more energy than moving with natural/standard gaits when they move the same distance and speed.

2. Dog robot walking in running gait or running in walking gait will have more amount of energy consumption compared to moving with natural/standard gaits when they move the same distance and speed.

3. Dog robot walking in running mode or running in walking mode will consume different amount of electricity compared to moving with natural/standard gaits when they move the same distance and speed.

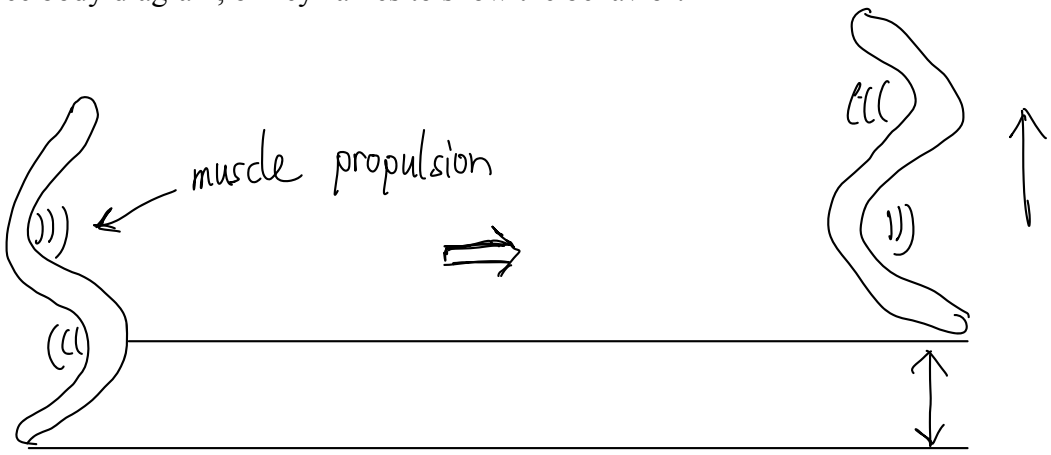
Animal 2

Name of animal: Snake

Describe the behavior that you found interesting:

The snake can move forward by just simply twist their body and muscle in a wave pattern. And they can move basically on any terrines smoothly.

Draw a sketch, free body diagram, or keyframes to show the behavior:



What do you think is the key factor (peak force, dexterity, precision, etc) that enables this behavior?

The key factor is the muscles that connected to the ribs, provide propulsion to help snakes to crawl, climb and swim. Their belly and ribs to push backward alternatively to provide opposite force to let snake move in lateral undulation pattern. Amount of force on each propulsion also affect the amount of turning of the snake.

How could a similar capability help a robot?

This moving mechanism can make the robots become limbless and be efficient in moving on different terrines. This can help reduce the number of external actuators by using built-in actuators inside the robot body. Furthermore, this means lower cost and less risk of actuator damage. By providing serpentine locomotion (lateral undulation) and concertina locomotion, this moving behavior is efficient to adopt any terrines due to very low center of gravity.

Generate a research question or hypothesis about this behavior or its application in robotics. Rewrite the question or hypothesis 3 times.

Hypothesis: The bioinspired robot can imitate snakes to move fast and stably.

1. The bioinspired robot can adopt snakes' shape and moving mechanism to move fast and stably.

2. The bioinspired robot can be snake shape and adopt serpentine locomotion to gain more traction on the ground, thus easier to move on different terrines.

3. The bioinspired robot can be snake shape and adopt serpentine locomotion to gain more traction on the ground with less numbers of failure and higher moving speed on steep terrain.

(Roll over)

Reference

1. Jessica Stewart, "Charming Animation Illustrates the Different Gaits of Four Legged Animals", February 28, 2018, Retrieved from https://mymodernmet.com/animal-gaits-animation-stephen-cunnane/