

**Rodrigo Sierra**

**Assignment 02**

**Robot Operating Systems & Platforms**

**Sitaram Ayyagari**

**Robot Sensors One-Pager**

**Boston Dynamics' Spot**

**Introduction**

Boston Dynamics' Spot is a quadruped (four-legged) robot designed for inspection and data collection in dangerous environments for humans. There are other activities that can be executed like monitoring, rescue, and military operations in industrial and commercial industries, whether indoor or outdoor in complex terrains.

**Key sensors**

Spot has several types of sensors, like:

- 1) Vision Sensors:
  - a. Stereo cameras: These cameras enable Spot to perceive depth and navigate visually, thanks to the black and white video.
  - b. Pan-tilt-zoom (PTZ) and Thermal cameras: These are optional and are used for detailed inspection in specialized tasks.
- 2) Mapping and navigation sensors:
  - a. Depth cameras and LiDAR: These sensors facilitate 3D environmental mapping, which is useful for identifying and avoiding obstacles.
  - b. Inertial Measurement Unit (IMU): Through this, the Spot can determine and quantify measures like angular velocity and acceleration required to achieve balance and postural control.

- c. Position and force sensor: These are essential to provide Spot with data about adaptive locomotion on even terrain.

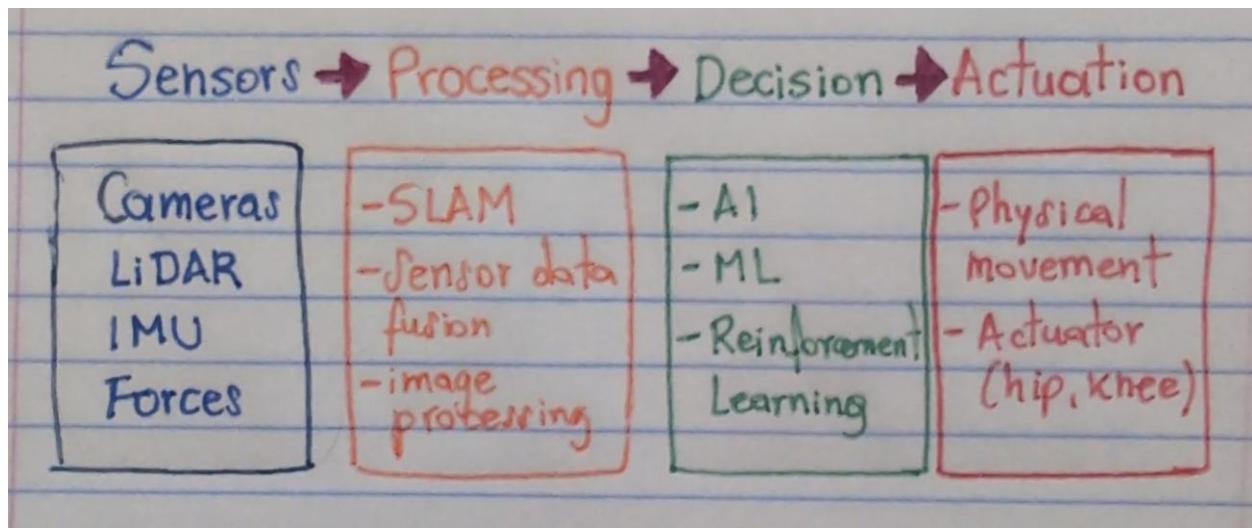
### Key actuators

Spot has three actuators (two on the hip and one on the knee) in each leg. These twelve servo motors operate according to necessity, enabling Spot to perform dynamic movements such as climbing stairs, walking, trotting, and regaining balance in response to sensor feedback. Another well known actuator is a robotic arm that is optional, but this can be used when required for the nature of the task.

### Autonomy level

According to the Spot's configuration, it is semi-autonomous or fully autonomous. Primarily, it operates semi-autonomous, which means that a human user can guide the Spot through tele-operation. However, it is essential to note that the Spot has autonomous navigation skills like obstacle avoidance and following pre-programmed paths.

### Pipeline sketch



### Safety Concerns

1. Collision risk with humans or objects in the environment during navigation, because it is possible in environments where people share space with Spots.

2. Sensor failure due to occluding cameras by several materials that can reduce navigation accuracy.

It is very sensible because it creates situations where Spot's leading falls or meets objects.

### **Mitigations**

Spot utilizes several practical solutions to mitigate failures. For example, when any single sensor fails, Spot utilizes information from other sensors to ensure it functions properly; this is known as redundancy. Another example is when something goes wrong; the Spot software stops the robot to avoid errors. Its strategy is known as fail-safes. Another example is when Spot generates signals or makes movements that allow humans to understand its intention to avoid accidents (HRI).

### **References**

1. <https://support.bostondynamics.com/s/article/About-the-Spot-Robot-72005>
2. <https://www.sensortips.com/featured/what-sensors-are-in-spot-the-robotic-dog/>
3. <https://utcn-robotica.ro/about-the-design-of-the-spot-robot-from-boston-dynamics/>
4. <https://support.bostondynamics.com/s/article/How-Spot-Avoids-Obstacles-49928>
5. [https://dev.bostondynamics.com/docs/concepts/about\\_spot/](https://dev.bostondynamics.com/docs/concepts/about_spot/)