Sensor Starters

Grades: 4 & Up
Time: 15 Minutes -PDQ 1 & 2

Subject: Physics, Technology, STEM
Topics: Angular Velocity, Radian

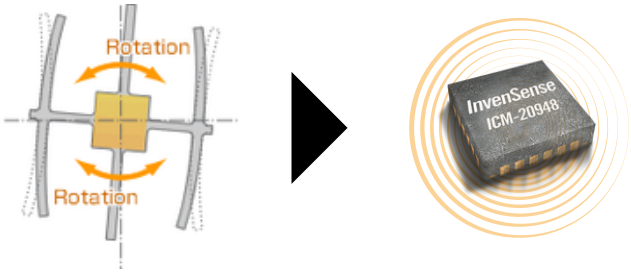
Meet the Gyroscope!

The gyroscope is a device that tells the change in the direction of an object while moving in a circular path. Gyroscopes are motion sensors that detect and measure the angular velocity of an object. Gyroscopes are most useful in navigation. Gyroscopes are essential in aircraft, ships, spacecraft, and robots.

Background

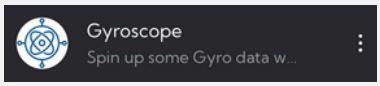
The gyroscope measures angular velocity, the rate at which an object rotates, and the direction it rotates. You have no doubt experienced linear velocity, the speed when you are driving down the road. But angular velocity is only applicable to objects that are moving along a circular path. For example, a race car on a circular track, a roulette ball on a roulette wheel, a windmill and a Ferris wheel have an angular velocity.

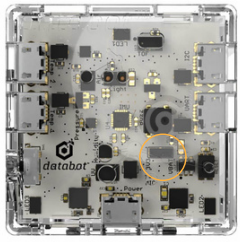
A gyroscope works through the use of "force" that affects the rotating objects. Just like the plane's flight path over the earth. The gyroscope consists of a double T-shaped crystal element. When they are rotated about the X/Y/Z axis, the force that affects the rotating element causes a vibration, the sensor converts the vibration detected into a number that represents the angular velocity.



What You Will Need/Prep

- databot™ 2.0 & Vizeey™
- IOS/Android Smart Device
- Use Vizeey™ to scan the QR Code for **Gyroscope**.





The gyroscope is one sensor in a module called an inertial measurement unit (IMU) located in the center of the databot™ PCB. Look for the label IMU on your databot!

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Important Terms

Axis: An axis is an imaginary line an object turns around that runs directly through the object's center. The plural of axis is axes - there are three axes of rotation on databot.

Axis of Rotation: The specific axis around which an object may be rotating.

Cartesian Coordinates: Describes position in three dimensions (3D) using the Cartesian Coordinates X, Y, and Z.

Gyroscope: Gyroscopes, also known as angular rate sensors or angular velocity sensors, are devices that sense rotation, circular motion, and angular velocity.

IMU: An inertial measurement unit (IMU) is a sensor device that measures and reports a specific force, angular rate, and sometimes orientation using a combination of an accelerometer, gyroscope, and sometimes a magnetometer.

Revolutions Per Minute (RPM): A unit of measure that expresses rotational speed as Revolutions Per Minute.

Rotational Motion: The motion of an object rotating around an axis.

Rotational Speed: Rotational speed indicates how fast the object rotates around its axis in a given time frame.

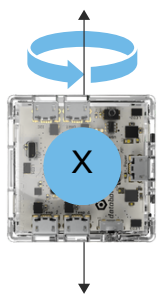
Gyroscopes sense circular motion around an axis of rotation.

What Units Do We Use for Angular Velocity?

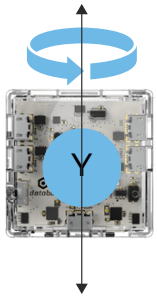
Angular velocity is the measure of the rotation rate, which tells how fast an object rotates or revolves around another object. It is measured in radians per second (r/s). Radians are a unit of angular measurement. Angular velocity measured in radians per second represents the rate of change of an angle in radians over time. One radian is equal to the angle subtended at the center of a circle by an arc whose length is equal to the radius of the circle. So, one radian per second means that an object is rotating such that it sweeps out an angle of 1 radian in one second.

Axes of Rotation

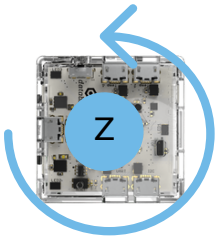
The **Cartesian Coordinate system** uses 3 **axes**, X, Y, and Z to describe the position of an object. These **axes** are also used to reference **axes of rotation** for an object in motion. You can rotate databot on each of its 3 **axes** and visualize the data using a **gyroscope**!



Switch side up.



Power port down.



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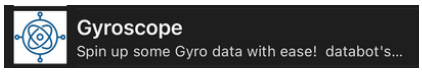
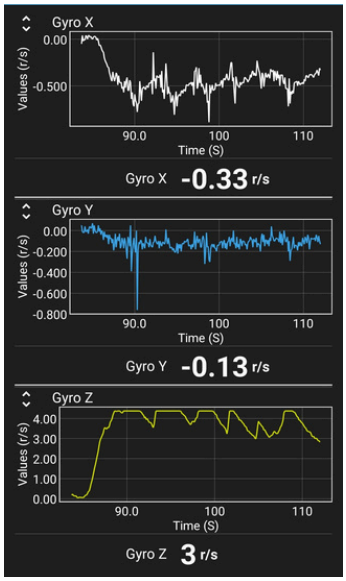
PDQ1 : Speed Spinner

Use databot to explore rotation and spinning using a sensor that measures rotational speed - the gyroscope. First, master cartesian coordinates and axes of rotation, then demonstrate your spinning prowess on your Z axis of rotation! Prepare to spin!

- Open the Vizeey app on your smart device.
- Turn on databot™ (using small button on left side)
- Tap on "**Gyroscope**" in Vizeey to load the experiment.



- You will be prompted to connect to databot.
  - Hint- if there is more than one databot in use, the one closest to you will be in blue!
  - A solid blue light on databot means you are connected.
- Start your experiment using:
  - Use these icons at the top of the screen in Vizeey to start and to pause the experiment.



- With Gyroscope running, you will see data displaying on three **axes** - X, Y, and Z.
- Hold databot flat in your palm and rotate it clockwise then counter clockwise and watch your **gyroscope** data. What **axis** is in motion?
- Next stand databot upright in your hand, power port down.

Repeat your experiment turning clockwise and counter clockwise and identify this axis. What direction is positive and which is negative?

- Finally, rotate databot 90 degrees to the right in your palm, the on-off switch should be on the top of the case.
  - Repeat your experiment turning clockwise and counter clockwise to identify this axis and the directions of rotation.

Now, identify the Z axis and the direction of positive spin for this axis and confirm this one more time with the Gyroscope experiment.

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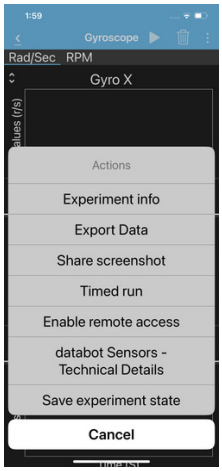
PDQ 2 : Spin Test

It's now time to test your rotational speed skills with your newfound knowledge of axes of rotation. In PDQ 2 your goal is to spin in place for 30 seconds at a constant rotational speed of 10 revolutions per minute (RPM). databot's gyroscope will guide you. You have three attempts. Go for it!

- Tap on "Gyroscope" in Vizeey to load the experiment.
- Carefully hold your databot on your head.
- Make sure databot doesn't fall when you rotate.
- Use these icons ▶ ⏸ at the top of the screen in Vizeey to start and to pause the experiment.
- Using the 3 Dot menu (top left of Vizeey screen)
  - Click on Timed Run, which gives you a 3 second delay to prepare then it starts a timer! The default is 10 seconds.



Start your experiment using: ▶

- Spin in the same spot, rotating on databot's Z axis for 30 seconds.
  - Try for a constant speed of 10 revolutions (turns) per minute.
- Practice a few times before your official run. Go ahead!

Runs	Revolutions
1st	
2nd	
3rd	

- If your speed value is negative, stop spinning and rotate in the opposite direction.

Check for Understanding

1. What is a gyroscope used for?
2. In your own words, explain **angular velocity**.
3. What are the units we use to express **angular velocity?**

Standards & Alignment

NGSS Standards

- Matter and its Interactions (MS-PS2-2)
- Energy (MS-PS3-1) (MS-PS3-2)
- Engineering Design (HS-ETS1-4)

Disciplinary Core Ideas

- PS1.A: Structure and Properties of Matter
- PS3.A: Definitions of Energy
- PS3.B: Conservation of Energy and Energy Transfer
- PS3.C: Relationship Between Energy and Forces
- HS-ETS1.B: Influence of Engineering, Technology, and Science on Society and the Natural World (Engineering, Technology, and Applications of Science)

Science and Engineering Practices

- 1st Practice: Asking Questions and Defining Problems
- 3rd Practice: Planning and Carrying Out Investigations
- 4th Practice: Analyzing and Interpreting Data
- 5th Practice: Using Mathematics and Computational Thinking
- 6th Practice: Constructing Explanations and Designing Solutions

Crosscutting Concepts

- Patterns
- Cause and Effect
- Energy and Matter
- Scale, Proportion, and Quantity
- Systems and System Models
- Stability and Change
- Structure and Function
- Patterns and Variability

ISTE Standards

- 1.1 Empowered Learner (1.1.d)
- 1.2 Digital Citizer (1.2.b)
- 1.3 Knowledge Constructor (1.3.a) (1.3.b)(1.3.d)
- 1.4 Innovative Designer (1.4.a)(1.4.b)
- 1.5 Computational Thinker (1.5.a) (1.5.b)
- 1.6 Creative Communicator (1.6.a) (1.6.b)