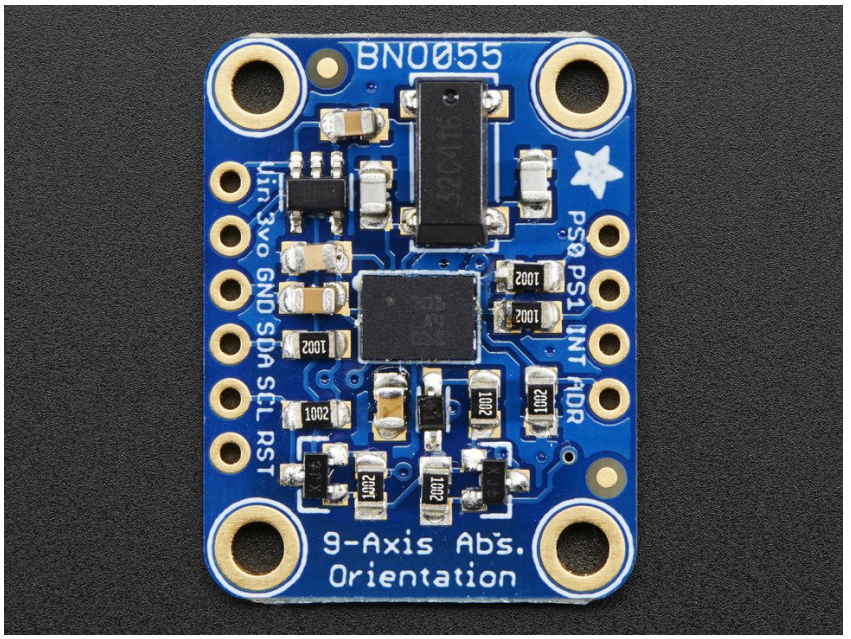
FTC Team #11587
Starry Knights

Tech Learning Series



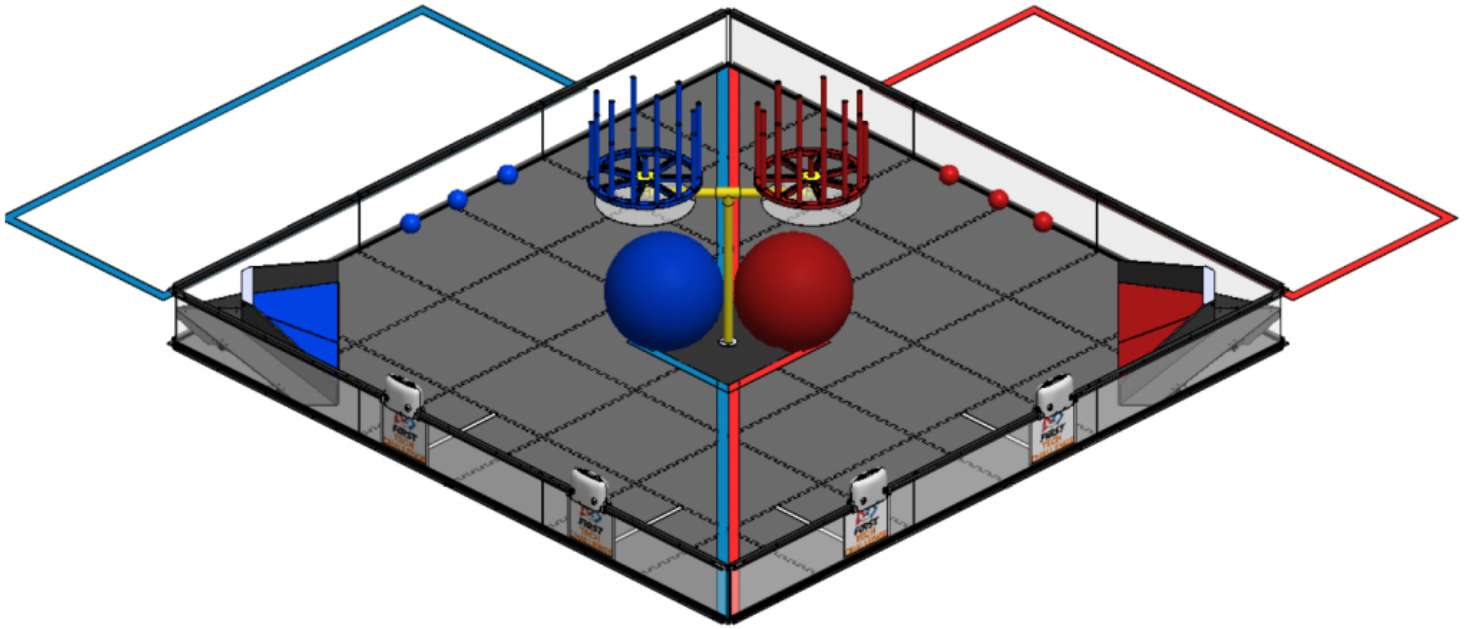
9-Degree of Freedom Navigation Sensor

Introduction

- Robot Navigation Requirements
- Navigation Challenges
- What is a “Degree of Freedom”?
- Adafruit 9-DOF Absolute Orientation IMU
- Adafruit IMU Components
- Practical Use of the Adafruit 9-DOF IMU

Robot Navigation Requirements

- The Challenge
  - Each year the FIRST® Tech Challenge game requires autonomous navigation around the arena to accomplish point-scoring tasks



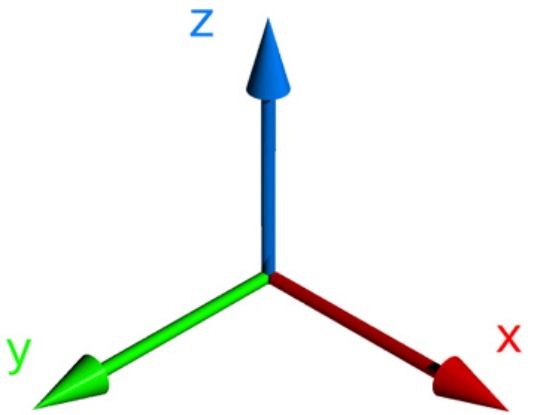
Navigation Challenges

- Robotic navigation is a difficult task requiring the integration of multiple sensor inputs to help the robot determine it's own location on the playing field
  - Have to know/determine starting position
  - Have to have/build a digital map of the field
  - Known vs. moving obstacle avoidance
  - High location precision required
  - Which sensor(s) do I use?
    - IR
    - Optical
    - Sonar
    - Accelerometer/Compass

Modern Robotics
Optical Distance Sensor

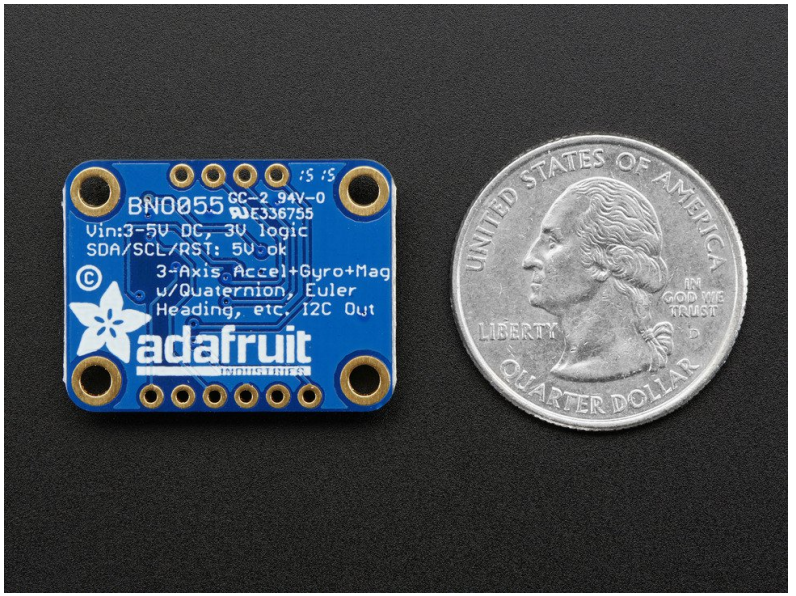
What is a “Degree of Freedom”?

- In robotics, a degree of freedom is simply a parameter which defines part of the state of a physical system (location, temperature, gravity vector, compass heading, etc.)
- Robotic navigation works in 3-dimensions (x,y,z) and also factors in rotation around those axes
- FTC games normally only require navigation in 2 of the 3 dimensions (x,y)



Adafruit 9-DOF Absolute Orientation Inertial Measurement Unit

- Several companies now make very compact, very accurate navigation components called Inertial Measurement Units
- Adafruit 9-DOF IMU integrates 3 different sensors (accelerometer, magnetometer, gyroscope) into one compact board with data fused together by an ARM Cortex processor



Adafruit 9-DOF IMU

- Accelerometer – measures proper acceleration of an object, or acceleration relative to an observer at rest in relation to the moving object
- Output units are typically indicated in *meters/second²*, but can be indicated as an a multiple of the local gravity acceleration, commonly termed *G-force*, or simply *"G's"*
- 1 G = 9.81 m/s²

Adafruit 9-DOF IMU

- Magnetometer – measures the direction, strength, or relative change of a magnetic field
- Output units are usually indicated either in *tesla*, or in *gauss*. (10,000 gauss = 1 tesla)
- Earth's magnetic field averages 20,000 to 80,000 nT

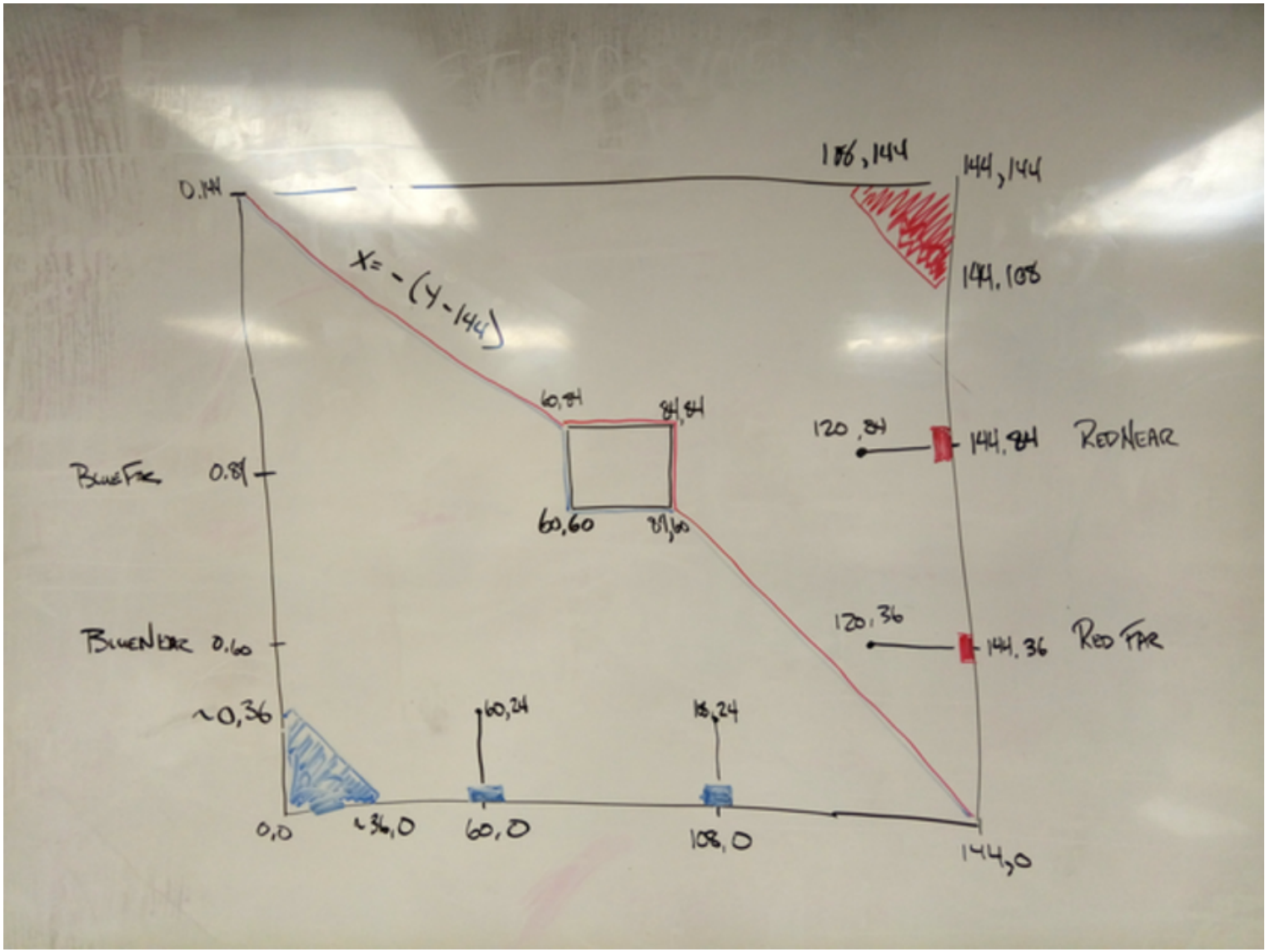
Adafruit 9-DOF IMU

- Gyroscope – measures rate of rotation around a particular axis
- Output units are usually indicated in *radians/second*.
- 1 radian = 57.296° or 2π radians = 360°

Practical Uses of Adafruit 9-DOF IMU

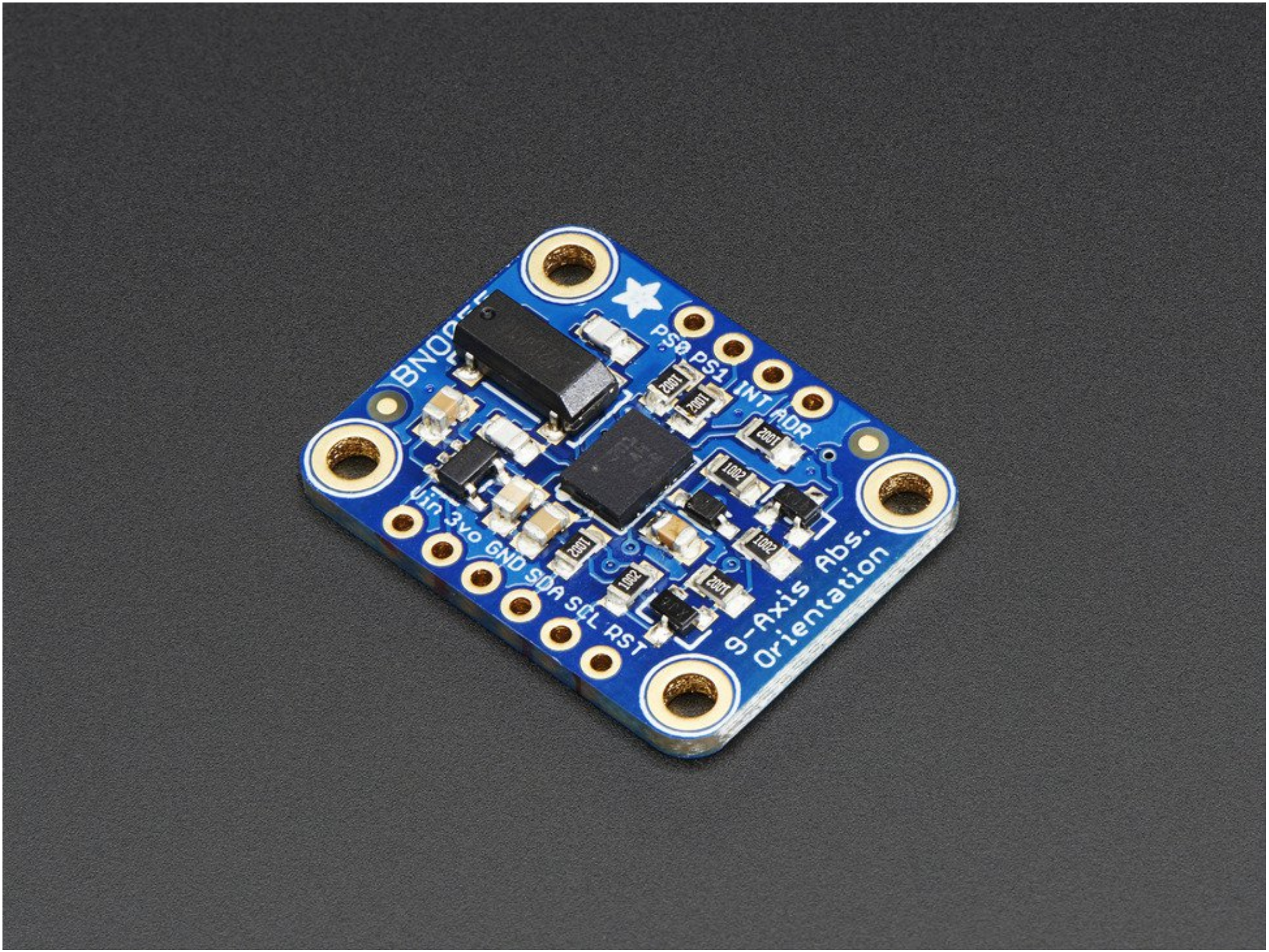
- When combined with rotary encoders from robot wheels and Hitch's sonar, the robot is able to locate itself precisely in the arena
- Allows sonar to be used not only for navigation, but also for avoiding other robots/obstacles in the playing field
- Gets us to a position where more precise sensors can be used (line following, optical photo recognition, etc.)
- By adding a "map" of the playing field to the robot software, creating Autonomous Mode programs becomes a simple task of telling the robot where to go on the map

Practical Uses of Adafruit 9-DOF IMU



Where To Buy

- Adafruit website: https://www.adafruit.com/products/2472
- Product Video: https://www.youtube.com/embed/EsgKAawwT9A?start=450&version=3&rel=0&autoplay=1
- Cost: $34.95
- Other 9/10-DOF IMU's are also available for similar prices


PS0 PS1 INT ADR
Vin 3Vo GND SDA SCL RST
9-Axis Abs.
Orientation